

The acquisition of goal-directed movement:
Developing and reporting a measure of learning readiness
for use in classroom settings with students
with motor performance needs

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Abstract

This thesis investigated how student movement difficulties might be related to motor learning opportunities in the classroom, and how classroom-related movement might be described as a learning progression and stage of learning assessed. At the time of this investigation, the movement aspects of classroom learning were not constituted as a curriculum domain, nor were classroom teachers equipped by their training to support motor learning advance for students experiencing difficulties. Consequently, a common practice was to recruit occupational therapy support via teacher-administered assessments developed by occupational therapists for this use. However, these were not underpinned by learning progressions enabling results to indicate stage of learning readiness – an important educational requirement.

This study employed educational measurement methodology to design an assessment framework describing the progressive learning of goal-directed movement, including its dimensionality and learning levels, to support teachers' instructional planning in this area. Drawing upon Vygotskian social constructivism, item response theory, and insights spanning over 60 years of motor behaviour research, movement was firstly defined accessibly as a goal-directed problem-solving strategy using the resources of the body one has. It was then operationalised as a judgement-based questionnaire, with items expressing five classroom-relevant aspects of postural control, transportation of self and objects, manipulation, communicative/ interactive skills, and performance sustainment. Empirical calibration of the item pool via assessment of 650 students with motor performance needs confirmed an acquisitional sequence with excellent measurement properties, following which standard setting by a Delphi panel of occupational therapy experts established 22 progressive learning levels for the dimensionalised scale and three possible report formats for different end-users. The result was an educational measure in-built with occupational therapy expertise that represented a new approach to occupational therapy assessment construction and provided a new way for allied health professionals and teachers to collaborate in support of classroom motor learning. Future research should undertake further collaboration with occupational therapists, to determine instructional strategies appropriate to each level of the scale.

Statement of Originality

This is to certify that:

- this thesis is my own work and has not been submitted to any other university or institution as part or whole requirement for any higher degree;
- due acknowledgement has been made to all material used; and
- the thesis is less than 100,000 words in length, exclusive of tables, maps, bibliographies, and appendices.



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List of Acronyms and Abbreviations

ACARA	Australian Curriculum, Assessment, and Reporting Authority
ADL	Activities of Daily Living
ADHD	Attention Deficit Hyperactivity Disorder
APA	American Psychiatric Association
ASD	Autism Spectrum Disorder
BOT-2	Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition
ChAS-T	Children's Activity Scale - Teacher version
CRPD	Convention on the Rights of Persons with Disabilities
DCD	Developmental Coordination Disorder
DDA	Disability Discrimination Act 1992
DHS	Department of Human Services
DSE	Disability Standards for Education 2005
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, 5 th edition
ECIS	Early Childhood Intervention Services
HPSQ	Handwriting Proficiency Screening Questionnaire
ICF	International Classification of Functioning, Disability, and Health
IEP/ ILP	Individualised Education/ Learning Plan
MABC-2 Checklist	Movement Assessment Battery for Children Checklist, 2nd edition
MOHO	Model of Human Occupation
MOQ-T	Motor Observation Questionnaire for Teachers
OTA	Occupational Therapy Australia
PDMS-2	Peabody Developmental Motor Scales, 2nd edition
PSD	Program for Students with Disabilities
School AMPS	School Assessment of Motor and Process Skills
SFA	School Function Assessment
TEAF	Teacher Estimation of Activity Form
UDHR	Universal Declaration of Human Rights
UN	United Nations
VCAA	Victorian Curriculum and Assessment Authority
WHO	World Health Organization
ZPD	Zone of Proximal Development

Chapter One: Introduction

Background to the Investigation

This thesis investigated how classroom movement difficulties experienced by students with physical impairments might be related to opportunities to learn to move in the classroom, and how the motor aspects of classroom learning might be described as an acquisitional sequence, and student level of learning assessed and reported. In part, interest in this topic came from my role as an occupational therapist in an international development organisation, working for and with adults with physical disabilities who were seeking to reach ongoing motor-based performance goals. On their reflection, good postural habits, maximisation of motor capacities, and physical self-confidence would have benefitted from a greater learning focus at school. The reasons they gave for this not occurring were borne out by the research, which noted the academic focus and fast pace of mainstream classroom learning (Egilson, 2014; Egilson & Traustadottir, 2009a; Kuhl, Pagliano, & Boon, 2015; MacDonald, Ziviani & Abbott, 2006), teachers' duty of care concerns and their limited training and experience in personalising learning for physical disability (Jenkinson, 2001; Occupational Therapy Australia [OTA], 2012; Reid, Chiu, Sinclair, Wehrmann & Naseer, 2006), and limited therapy provision in mainstream settings (OTA, 2016; Polatajko & Mandich, 2004; Rainforth, 1992; Silverman & Bourke-Taylor, 2009). In many instances, learning support staff had been recruited to complete the movement aspects of classroom activities for these students, causing further loss of motor learning opportunities (Blatchford, Russell & Webster, 2012; Broer, Doyle & Giangreco, 2005; Clark, Macarthur, McDonald, Simmons-Carlsson, & Caswell, 2007; Mortier, Desimpel, Schauwer, & Van Hove, 2011). Consequent discussion at the time of this research with students electing to return to physical disability specialist schools from mainstream settings revealed these to be ongoing concerns (see also Curtin & Clarke, 2005; Diéz, 2010; Quicke, 2008; Pitt & Curtin, 2004).

Rationale

At the time of this investigation, Australian government inquiries into the education of students with disabilities identified ongoing challenges for classroom teachers in facilitating student learning across the increased range and type of learning need (Australian Government Department of Education and Training [DET], 2018; Commonwealth of Australia, 2002, 2016; Department of Education and Training [DET] Victoria, 2016b; Victorian Auditor-General's Office, 2012; Victorian Equal Opportunity and Human Rights Commission (VEOHRC), 2012). One aspect of this challenge that was noted early in the discussion was lack of curriculum information and advice about how learning developed and what it looked like at levels preceding school entry (Commonwealth of Australia, 2002). Lacking that knowledge, teachers tended to place low learning expectations on students working at those early levels. These inquiries concerned academic learning and students with intellectual disabilities; however, other research noted lack of knowledge about learner ability also contributed to low expectations in the area of motor learning and children with physical disability (Clemente, 2017; Government of South Australia, 2010; McNiell, Lante, & Pill, 2017; Mortier et al., 2011; Shields & Synnot, 2016; Tindall, MacDonald, Carroll, & Moody, 2015).

To improve teacher capacity to judge ability and devise tailored learning programs, in 2009, the six levels of the Victorian curriculum and assessment framework in Australia were extended to incorporate abilities below those traditionally assumed at school entry (Department of Education and Early Childhood Development [DEECD] Victoria, 2009; Victorian Curriculum and Assessment Authority [VCAA], 2015; Woods & Griffin, 2013). This work provided four additional levels of progress not only for each of the traditional subject areas, but for the “processes of physical, personal and social development and growth” that had been incorporated into the Victorian curriculum as General Capabilities

with the introduction of the Victorian Essential Learning Standards (VELS) in 2005 (VCAA, 2005, p.1). General Capabilities described foundational skill subjects considered essential for effective functioning within and beyond school that were regarded as “first-order” areas of learning containing “discrete sets of knowledge and skills”, and therefore deemed to be subjects with equal curriculum standing (Howes, 2012, p.9). While it was recognised that many children acquired these capacities naturally and without need for explicit instruction, this was evidently not always the case, particularly for those entering school without the wherewithal or background opportunities to support independent learning (Howes, 2012). Hence, one argument for this expansion of the curriculum was the universal design principle that such input was “good for all and essential for some” (Dancza et al., 2017, p.270). However, within commitments to develop these important undergirding areas, no mention was made of classroom-related motor skill acquisition and the learning needs of students with motor performance needs, though this capability was also, conceivably “constituted by a discrete set of knowledge and skills ... not fully incorporated in any (other) learning area” (VCAA, 2015, p.13; see also Chung & Patel, 2015; Giroux, Woodall, Weber, & Bailey, 2012; Mancini & Coster, 2004; Missiuna, Rivard, & Pollock, 2004; Missiuna et al, 2012; Penner-Wilger, Fast, LaFevre, Smith-Chant, Skwarchuck, Kamawar, & Bisanz, 2007).

The importance of motor skills in classroom learning was evident in scattered physical task descriptions in curriculum documents; for example, the Australian Curriculum for the subject of English noted turning book pages, copying actions, drawing, and writing; the Mathematics curriculum mentioned pattern creation with physical objects and manipulation and use of objects and mathematical equipment; and the Science curriculum required drawn observations and the use of touch to gather information, among many other physical skills (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2014; VCAA, 2015). These skills, many involving the hand and “manipulative tasks” (Fisher &

Munkholm, 2008, p.124; see also Coster et al., 1998; Fisher, Bryze, Hume, & Griswold, 2007; Mancini & Coster, 2004) were different to those covered by the Health and Physical Education (HPE) curriculum, which aligned the ‘Moving our body’ strand to fundamental movement skills for sports and games, challenge and adventure activities, and rhythmical and expressive dance movement (ACARA, 2012). Looking further afield, this scant or absent mention was also noted in the curricula of other countries; for example, British Columbia’s New Curriculum (curriculum.gov.bc.ca), the Finnish National Core Curriculum (Finnish National Agency for Education, 2014), the USA New Jersey Student Learning Standards (state.nj.us/education/cccs), the New Zealand Curriculum (nzcurriculum.tki.org.nz), and the United Kingdom’s P Scales (Department for Education, 2017). In the latter case, while some developmentally sequenced motor skills were evident in the early learning levels of traditional subject areas, these largely followed maturationist milestones and normative motor outcomes (Campbell, 2012; Dalton, 2005; Thelen, 1995, 2000) – the focus was not on their learning, but their use to describe learning in the focal subject area.

A more formal framing of this topic came from analysis of a two-year research investigation by New Zealand’s Ministry of Education Advisory Reference Group for Students with Physical Disabilities into school service provision for children with physical disability (Clark et al., 2007; McDonald, Caswell, & Penman, 2001; Ministry of Education, 2002). From extensive consultations with children and parents, teachers and principals, school-based health professionals (i.e., occupational therapists and physiotherapists), and representatives of disability organisations and education unions, this group concluded that:

- significant educational disadvantage often accompanied physical disability,
- lack of teacher attention to physical needs was due in part to their lack of training,

- health professionals, such as occupational therapists and physiotherapists, were needed to support successful curriculum access for these students, and this required a successful health-education interface in the classroom,
- this interface and need for collaborative classroom practice were being impacted not only by teacher lack of knowledge about physical disability and motor skill development, but by health professional lack of knowledge about the curriculum and nature of classroom learning, the latter encapsulated in use of medically-based descriptions, assessment reports, and deficit-remediation models of intervention.

This latter point – the capacity and training of health professionals to work in educational settings – contributed a second rationale for this research. Occupational therapy was identified as having an important role and set of skills in relation to classroom motor skills development (American Occupational Therapy Association [AOTA], 2011; Banks, Rodger, & Polatajko, 2008; Cameron, Chen, Blodgett, Cottone, Mashburn, Brock & Grissmer, 2012; Case-Smith & Exner, 2015; Colangelo & Olson, 2013; Forsyth, Maciver, Howden, Owen, & Shepherd, 2008; Hollenbeck & Miller, 2013; Missiuna, Pollock, Egan, DeLaat, Gaines, & Soucie, 2008; O’Brien, 2015; OTA, 2016; Polatajko & Mandich, 2004; Rodger & Brandenburg, 2008; Roston, 2010; Smits-Engelsman, Blank, van der Kaay, Mosterd, Vlugt, Polatajko, & Wilson, 2013). This formed part of their broader concern to support *occupational* roles – occupation understood broadly as all the ‘doing’ aspects of life (AOTA, 2014; OTA, 2016; Townsend & Polatajko [CAOT], 2007; Trombly, 1993). In relation to the motor requirements needed to achieve the occupational role of classroom learner, occupational therapy assessments considered multiple aspects of classroom-related functional movement and described classroom tasks and environments (e.g., Coster et al., 1998; Fisher et al., 2007; Henderson, Sugden, & Barnett, 2007). However, to support educational requirements and goals, an educational, and specifically a *curricular learning* approach

would ideally also be considered (McDonald et al., 2001; see also Boshoff & Stewart, 2013; Dancza et al., 2017; Fisher, 2013; Kramer, Luebben, & Hinojosa, 2010; Whyte & Hart, 2003). According to this approach, evidence-based interventions supporting change would involve “formative assessment” to identify learning readiness (Black & Wiliam, 1998a, p.7; see also Australian Government DET, 2018; Bloom, Hastings, & Madaus, 1971; Griffin, 2007; Heritage, 2008; Maloney, Confrey, & Nguyen, 2014; Shepard, 2000, 2007; Tomlinson, 2014; Vygotsky, 1978; Wilson, 2009), and personalised intervention to support iterative student progress “through successive levels of difficulty” (Harden & Stamper, 1999, p.141; Howes, 2012; VCAA, 2015). Undergirding this, a prior established “developmental learning continuum”, or theory of learning in the domain would be identified (VCAA, 2015, p.9; see also Messick, 1984; Victorian DET, 2016; Wilson, 2009). However, at the time of this research, such a *curricular* approach to unpacking learning domains was not found in school-based occupational therapy assessment and intervention literature, nor were references found to the concept of learning progressions in the profession’s discussions of acquisitional frames of reference or teaching-learning approaches to rehabilitation more broadly (Berkeland & Flinn, 2005; Greber & Ziviani, 2010; Greber, Ziviani, and Rodger, 2007, 2011; Luebben & Brasic Royeen, 2010).

Purposes of the Investigation

Arising from the foregoing analysis, the primary purpose of this investigation was to draw upon the different skills and perspectives of occupational therapy and education to describe an abilities-based, criterion-referenced learning progression and formative assessment of classroom-related, goal-directed movement that would enable health-education teams to focus their intervention on what the student was ready to learn. The goal of usefulness to team planning would involve establishing the multi-dimensionality of this learning domain, in keeping with the multi-dimensional conceptualisation of functioning and disability in the

rehabilitation and health assessment literature (World Health Organization [WHO], 2001, 2002) and arguments that reporting and working from a single dimensional summary of ability provide less support to prioritisation and targeted attention in busy classrooms (Kuhl et al., 2015; Wilson & Hoskens, 2005). Consistent with the non-age-referenced, substantially described “levels of learning” of the Victorian Curriculum (VCAA, 2015, p.14) and the recommendations from the literature on differentiated instruction (see Chapter 2), this work would also involve establishing performance levels, or standards – skill regions along the learning progression referenced to domain criteria rather than grade- or age-expectations (Cizek & Bunch, 2007; Kane & Tannenbaum, 2013; Wilson, 2005; Wyse, 2013), and consideration of reporting formats for different stakeholder needs. Finally, achievement of an abilities-based rather than deficit-oriented measure would be evaluated by establishing whether students with different impairment characteristics were able to be identified within the levels of the scale according to their abilities.

Research Questions

To meet the purposes of the investigation, the following research questions were formulated:

1. What is a typical developmental learning progression in goal-directed movement for students with motor performance needs?
2. To what extent is the developmental learning progression a multidimensional construct?
3. What are the major stages of skill acquisition along this progression, and how are results best reported?
4. How do student background characteristics impact goal-directed movement performance and learning?

Thesis Structure

This thesis consisted of ten chapters, structured around the research questions. The current chapter has set out the background and rationale for the study, noting the research questions guiding its activities. The second, third, and fourth chapters contained reviews of the body of research and scholarship pertinent to the study – Chapter Two documenting the history and policy underpinnings for educational reform and best practice in the context of disability, and particularly physical disability, Chapter Three exploring the construct of human movement and the nature of its growth through learning, and Chapter Four considering different approaches to motor skill assessment and proposing a conceptual framework for defining the construct of interest that drew on the combined insights of Vygotsky (1978), Glaser (1963, 1981) and Rasch (1960, 1980), as brought together by Griffin and colleagues (Griffin, 2007, 2009, 2018; Griffin et al., 2004). The fifth chapter described the methodology of the two studies conducted to answer the research questions – a scale development and calibration study addressing the first two questions; a standard-setting study by Bookmark Method responding to the two parts of the third research question, and a cross-tabulation study answering the final question of the investigation. The sixth, seventh, eighth, and ninth chapters provided the results of the two studies by responding to each of the research questions in turn. Thus, the sixth chapter established the learning progression, the seventh its dimensionality, the eighth chapter its performance standards and optimal reporting formats, and the ninth chapter the significance of associations between performance on the scale and the independent variables of impairment severity and functional location. The tenth chapter presented a final discussion of results, suggesting implications for occupational therapy assessment practice, and educational curriculum content.

Chapter Two: Educational Reform and Practice Relative to Physical Disability

The goal of this chapter is to review a body of current policy, research, and scholarly writing on the education of students with disabilities with reference to the motor aspects of classroom learning and students with motor performance needs. Following a definition of physical impairment, Foreman's (2015) proposal of three influential drivers motivating educational access arguments – social justice and human rights, legislation, and findings from research – are used to frame this review. Thus, the first of these sections considers the rights basis for access to education through a historical overview of international and national policies and statements and rights-based movements and models, the second section summarises selected international and national legislative documents relating to the education of students with disability, particularly in Australia, and the third section presents key research findings regarding classroom-related motor skill development – answering questions on motor learning capability, best-practice instructional methodology, and justification for including motor learning in the general curriculum.

Physical Impairment

Definition of Impairment

Without reference to evaluative judgements, bodily impairment can be described as a biological interference to the performance capacity of the body to achieve goals, on the understanding that the natural functioning of a component or sub-component of the body is its species-typical contribution to goal achievement (Boorse, 1975). This definition is consistent with a Platonic understanding of bodily health as “the performance by each part of its natural function” (Boorse, p.58). To describe impairment in this way is to reflexively describe health as a state where all components and sub-components of the body are working to support goal achievement according to each component's (empirically analysable) design.

On this definition, ‘health’ is not a comprehensive term, describing total wellbeing, but merely a description of a typically functioning body. For the individual, the worth of this functioning is the extent to which it supports achievement of valued goals – identified and justified independently; “There is presumably no intrinsic value in having the functional organisation typical of a species if the same goals can be better achieved by other means” (Boorse, p.61).

Such a description of typical human functioning aligns with the meaning of ‘performance capacity’ in the Model of Human Occupation (MOHO) – there defined as “the ability for doing things provided by the status of underlying objective physical and mental components” (Kielhofner, 2008, p.68), also impacted by an additional subjective, or lived body, component – “how these are used and experienced in performance” (Kielhofner, p.152). Performance is thus seen as a function of objective and subjective components, evaluated by observing the individual in action. Where performance is impacted by impairments at underlying structural and functional levels, rehabilitation services aim to maximise functioning and minimise negative consequences through a combination of deficit remediation or repair, instruction in compensatory strategies, and modifications to tasks and environments to maximise participation and achieve functional goals (Gibson et al., 2009; Hammell, 2006; Wade, 2005). One recipient group of such rehabilitation efforts is school-aged children with physical disability.

Physical Disability in Childhood – Description and Prevalence

Physical disability is defined as limitations in voluntary movement or mobility (Australian Bureau of Statistics, 2012b), ranging from mild interference to independent functioning, to profound impact on all areas of voluntary physical functioning, including communication and self-care (Missiuna & Pollock, 1991; Missiuna, Smits, Rosenbaum, Woodside, & Law, 2001). At whatever level, physical disability directly impacts an

individual's ability to explore, interact with, and master the environment (Mogford, 1977). In 2012, of the 8.5% (295,000) of Australian school-aged children identified by the Australian Bureau of Statistics (ABS) as having a disability, just under a third (30.3%, or 88,800) had a diagnosed physical disability (ABS, 2012, 2015). These children were more likely than other disability groups to be educated in mainstream settings, and to be receiving the least, and that reducing, funding support – for example, between 2008 and 2012, funding for Autism Spectrum Disorder (ASD) increased by 45%, severe behaviour disorder by 38.5% and intellectual disability by 11.6%, while funding for physical disability decreased by 10% (Victorian Auditor-General's Office, 2012).

Diagnosis of disability in childhood is difficult, as it is impacted by rate of development which varies from child to child (American Psychiatric Association [APA], 2013; Law, Finkelman, Hurley, Rosenbaum, King, & Hanna, 2004; Missiuna et al., 2001; Myers, 2013; Skues & Cunningham, 2011). Medical diagnoses provide descriptions of clusters of signs and symptoms relating to disorders or conditions, aligning these to anatomical structures and physiological and psychological functions (Effgen & Howman, 2013). These descriptions do not tell the whole story of disability, which is impacted by other factors within and external to the child, including the nature of their response, their personal supports, and the opportunities and barriers existing in their environment (Palisano, Campbell, & Harris, 2012; Shepherd, 1992; WHO, 2001). In addition, many conditions, for example, ASD and cerebral palsy (CP), present with wide motor variability, including no functional limitation at all (Australian Institute of Health and Welfare [AIHW], 2004). Types and Australian prevalence of some conditions in children that impact physical functioning are provided in Table 1, using the statistics provided by AIHW (2004) unless otherwise specified.

Table 1 *Conditions with Physical Functioning Impacts*

Type of condition	Diagnostic examples	Prevalence (%)	Source (unless AIHW, 2004)
Neurodevelopmental disorders	Attention Deficit Hyperactivity Disorder (ADHD)	7	Lawrence, Johnson, Hafekost, Boterhoven, Sawyer, Ainley, & Zubrick, 2015
	Autism Spectrum Disorder (ASD)	1.5	Autism Aspergers Advocacy Australia, 2015
	Cerebral palsy	0.2-0.3	
	Developmental Coordination Disorder (DCD)	5-6	APA, 2013; Zwicker, Missiuna, Harris, & Boyd, 2012
	Down syndrome (incl. terminations)	0.25	
	Duchenne muscular dystrophy	0.03	mdaustralia.org.au
	Epilepsy	0.4-1	
	William's syndrome	0.002-0.004	
Congenital/ acquired childhood conditions with associated motor/activity impairments	Acquired brain injury	0.3	
	Asthma	2.1	
	Cystic fibrosis	0.04	cysticfibrosis.org.au
	Juvenile rheumatoid arthritis	0.1-0.4	AIHW, 2008
	Neural tube defects (incl. terminations)	0.14	
	Neurofibromatosis	0.04	ctf.org.au
	Very low birth weight (<1500g)	1	AIHW, 2015

Statistically, almost twice the number of school-aged children with diagnosed physical disability had movement limitations (60%, or 170,500), highlighting the extent to which many kinds of disability impact on physical functioning (ABS, 2015). For example, children

with severe and profound intellectual disability are characterised by limitations to movement and limited opportunities to learn to move (Houwen, van der Putten & Vlascamp, 2014), those with less severe intellectual disability have greater difficulty than their same-age peers in performing manual dexterity, ball and balance skills (Dewey & Tupper, 2004; Vuijk, Hartman, Scherder, & Visscher, 2010), children born prematurely experience severe difficulties with motor performance which in turn affects their academic progress (Brown, 2013), children with Down syndrome experience delays in all domains of development (Gémus, Palisano, Russell, Rosenbaum, Walter, Galuppi, & Lane, 2002), and a 2010 meta-analysis confirmed substantial motor coordination deficits in children with ASD, across a wide range of behaviours (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010; see also Brown, 2013).

The functional classroom impact of these conditions can be seen in the areas selected for evaluative comment by the Victorian Educational Needs Questionnaire (ENQ), which describes levels of educational need in relation to seven disability categories used to determine funding support – physical, vision, hearing, behaviour, intellectual, autism, and severe language with critical educational needs (Department of Education and Training, 2017). In addition to the *health and wellbeing* benefits of physical activity (An & Goodwin, 2007; Block, 2007; Coates, 2011; Evans & Penney, 2008; Lytle, Lavay & Rizzo, 2010; Martin, 2013), and the support for *cognitive* functioning that physical ability supplies (Booth, Leary, Joinson, Ness, Tomporowski, Boyle, & Reilly, 2014; Donnelly & Lambourne, 2011; Ratey & Loehr, 2011; Tomporowski, Lambourne & Okomura, 2011), the ENQ notes that movement proficiency supports *physical* classroom participation through enabling mobility (wheeled or walking), object manipulation, expressive communication, safety management, and self-care (toileting, eating and dressing).

The level of impact of movement difficulties on classroom functioning is also significant. Motor skills underpin all engagement in childhood functional, play, and social activities (Jones, Riethmuller, & Hesketh, 2011). Estimates indicate the likelihood of difficulty with classroom fine-motor tasks is as high as 90-98% for children with cerebral palsy, autism spectrum disorder (ASD), and attention deficit-hyperactivity disorder (ADHD) (Chung & Patel, 2015; Fournier et al., 2010). Given that 30 to 60% of the school day is comprised of fine-motor tasks (Chung & Patel; McHale & Cermak, 1992), with time spent handwriting increasing in frequency across the schooling years (National Literacy Trust, 2015), this figure is not surprising, and explains the statistic from one study of 62% of occupational therapy referrals being for classroom-related fine-motor difficulty (Dunford, Missiuna, Street, & Sibert, 2005; see also Hoy, Egan, & Feder, 2011; Overvelde & Hulstijn, 2011; Schwellnus, Carnahan, Kushki, Polatajko, Missiuna, & Chau, 2012). Further indication of the impact of this prevalence on classroom participation for students in Australia has been provided by the Nationally Consistent Collection of Data for School Students with Disability (NCCD_SWD) (Australian Government Department of Education and Training, 2016), first reported in 2015, which identified 110,150 students received school-based adjustments specifically for physical difficulties, including differentiated teaching and supplementary tuition, individualised learning plans (ILPs), and provision of disability support personnel (see Appendix A for a breakdown and explanation of the different ABS and NCCD statistics).

In broad summary, at the time of this investigation, approximately 15% of all Australian students (60% of those with disabilities) were experiencing some kind of motor difficulty at school (Lalor, Brown, & Murdolo, 2016). Of these 170,500 students, 90,000 had a physical disability diagnosis. In relation to support in the classroom, over 110,000 Australian students, or 16% of all those receiving assistance, required this help for physically-related reasons. It is this experience of movement difficulty during classroom learning that is the interest of this

investigation, an interest intersecting with international and Australian social justice calls for equality of educational access for all children. This historical and policy framework for educational equality for children with disability will be explored next.

Declarations, Movements and Models

Rights-based Statements and Conventions

Education is a basic human right and part of a just society (Ainscow & César, 2006; Anderson & Boyle, 2015; Dixon & Verenikina, 2007). This perspective informs international and Australian declarations and policies and rights-based movements and models.

International declarations and policies. A guide to implementing Article 24 of the UN Convention on the Rights of Persons with Disabilities (CRPD) (United Nations (UN), 2006), relating to the right to education, noted the background to arguments for educational access in the form of international declarations, statements and conventions, beginning with the 1948 Universal Declaration of Human Rights (UDHR) (UN, 1948) (Reiser, 2012). The UDHR legislated for the right to free and compulsory public education for every child (Article 26), and was followed by various more specific declarations – the Convention Against Discrimination in Education (1960), the Convention on the Rights of the Child (1989), the World Conference on Education for All (1990), and the comprehensive Salamanca Statement and Framework for Action on Special Needs Education (United Nations Educational Scientific and Cultural Organization [UNESCO], 1994). This last document, “arguably the most significant international document ... in the field of special education” (Ainscow & César, 2006, p.231), promoted the right to a regular education for every child, regardless of capacity, and advocated for improving quality education adapted to children’s needs rather than the reverse (UNESCO, 1994, Article 28). Following the Salamanca Statement, related legislature continued to affirm this right to a regular curriculum enriched with additional

instructional support. This could be seen in Article 24 of the CRPD, which called for accommodations and individualised support measures under the instruction of teachers trained to support disability requirements, with the goal of “full and equal participation in education and the community” (UN, 2006, p. 17). UNESCO’s (2009) Policy Guidelines on Inclusion in Education reiterated that disability-accessible education entailed an adaptive and individualised curriculum and a personalised approach to instruction (see also Culham & Nind, 2003). Regular schools were called to develop ways of teaching that responded to individual differences and could benefit all children (UNESCO, 2009). This was defined as quality education and related back to the Education for All (EFA) movement (World Conference on Education for All, 1990), with the result that disability-accessible education and quality education became linked.

Australian national policy statements. Australia has a federal system of government, which gives constitutional responsibility for school education to its six states and two territories. Consequently, and because Australia has not seen the ideological extremes of other countries, national policy statements and curriculum strategies in response to international calls have tended to follow rather than precede local initiatives (Jenkinson, 2001). The national commitment expressed in the 1989 *Hobart Declaration on Schooling* mentioned briefly the need for equal education opportunities for groups with special needs (Ministerial Council on Education, Employment, Training and Youth Affairs [MCEETYA], 1998). The *Adelaide Declaration on National Goals for Schooling in the Twenty-First Century* (1999) called for socially just schooling, free from negative effects arising from disadvantage such as disability, where “the learning outcomes of educationally disadvantaged students improve and, over time, match those of other students” (MCEETYA, 1999, p.230). The most recent *Melbourne Declaration on Educational Goals for Young Australians* (2008) committed Australia’s governments to providing all students with access to high quality

education free from discrimination against disability” and characterised by a personalised learning approach. These commitments were reiterated in the Council of Australian Governments’ (COAG) *National Disability Strategy 2010-2020* (2011), which called for high quality educational programs for all.

At a policy level, work towards an Australian National Curriculum also contained commitments to greater educational access, with disability considerations in its Curriculum Framing Papers for English, Maths, History, and Science (Berlach & Chambers, 2011), and a goal of high-quality in the addressing of individual learning needs (ACARA, 2013a, 2013b). In relation to motor learning needs, the participation of students with physical disability in physical games, dance and sport were specifically addressed through the Health and Physical Education and the Arts – Dance curricula. Diversity of ability was recognised and affirmed in these documents, including the need to build on student strengths (ACARA, 2014).

In conclusion, international declarations and Australian national policy statements have called for a curriculum that values diversity and is capable of adaption to individual learning needs, including needs raised by physical disability (Gee, 2002). These arguments for the right of people with physical disability to access life and learning opportunities on the same basis as others have received further support from international rights-based movements, which, however, have proposed different ways to respond.

Movements for Rights and Social Justice

The civil rights movement. Contextually, the UDHR, which began rights-based inclusion commitments, was drafted in the years immediately following the Second World War. In the United States, the origin location of inclusive education (Wu, Ashman & Kim, 2008), its requirements resonated with arguments about diversity and social justice arising from the civil rights movement of the 1960s and 1970s, which called for desegregated education for ethnic minorities, and influenced other excluded groups to mobilise similarly

(Forlin, Chambers, Loreman, Deppeler, & Sharma, 2013; Poed & Elkins, 2012; Thomas, 2013). In Australia, though wider politics of ethnicity did not feature, parents of children with disability and members of voluntary organisations also began to advocate for educational access for children previously considered “uneducable” or “untrainable” (Gartner & Lipsky, 1987, p.369; see also Ashman & Elkins, 2009; Jenkinson, 2001; Jordan, 2008). This advocacy was supported by interventions such as Normalisation and Conductive Education, which were committed to bringing about greater societal inclusion (Culham & Nind, 2003; Jenkinson, 2001).

Normalisation and Conductive Education. The concept of normalisation came from Bank-Mikkelsen (1969) and Nirje, (1970) in Scandinavia, and Wolfensberger (1972, 1980), who argued that learning environments for people with disability should be as close to normal as possible, and that endemic devaluing of people with intellectual disability was best combated by enabling participation in ordinary life (Foreman, 2015; Konza, 2008). Wolfensberger developed a behavioural science basis for normalisation, which he called social role valorisation (SRV), whose principal work was to end negatively valued difference and enable people to take up societally valued roles (Wolfensberger, 1980; 2011). Wolfensberger was concerned for individual skill development that would enable people with disability to take up valued societal roles and live ordinary lives, capitalising on existing values (Culham & Nind, 2003; Slee, 2011; Wolfensberger, 1995), an agenda described as “to become like others” (Tilstone, Florian, & Rose, 1998, p.15).

Normalisation has been credited by its supporters with developing skills and competencies that have minimised the experience of disability, underwritten commonalities of experience, supported people to participate in socially valued roles increasingly in mainstream settings, enabled development and maintenance of ordinary community relationships, and allowed greater freedom of choice and opportunity to be exercised

(Culham & Nind, 2003). In addition, organisations supporting people with disability were critically and helpfully assessed against the principles it espoused (Elkins, 1985).

While normalisation and social role valorisation focused on capacity-development for people with intellectual disability, a similar goal of attaining to normal functioning for people with physical disability inspired Conductive Education – a Hungarian therapeutic educational program developed in 1948 for children with cerebral palsy (Kozma, 1995). Conductive Education utilised task-oriented learning, use of rhythmic speaking and singing to facilitate and correct motor action, integration of motor learning into everyday activities, the use of natural settings for intervention, and intensive and daily practice to improve *orthofunction*, or the ability to function without aids or appliances in typical, age-appropriate social settings (Blank, Kries, Hess & Vosse, 2008; Oliver, 1989; Ratcliffe & Sanekane, 2009). It proved popular with families, due to its intensive intervention, holistic focus on combined motor, communication, independence and academic goals, utilisation of groups, and incorporation of parents as integral partners (Reindal, 2008). Some studies demonstrated improved motor functioning; for example, an individual cohort study of 64 3-6-year-old children with cerebral palsy provided with Conductive Education indicated a 25% improvement in coordinative hand function, compared to a control group (Blank et al., 2008; see also Lotan, Schenker, Wine & Downs, 2012). In addition, social and personal benefits were claimed, relating to the intensive group nature of Conductive Education programming (Lind, 2003; Schenker & Sutton, 2014). However, a later systematic review summarising the best available evidence noted a lack of superiority of Conductive Education over other more standard and less intensive approaches, consequently advocating against its continued use (Novak, McIntyre, Morgan, Campbell, Dark, Morton, ... & Goldsmith, 2013). Philosophically, both normalisation and Conductive Education were criticised as promoting homogeneity and an “ableist” concept of normality (Slee, 2014, p.277), and charged with attempting to change the

person with a disability to fit more within typical society, rather than celebrating and valuing individual difference (Culham & Nind, 2003; Giese & Ruin, 2016; Oliver, 1989). A medical habilitation model was proposed as responsible for this, through a focus on deficit reduction by “repetitive training of weak functions” (Reindal, 2008, p.136), rather than more usefully working with strong functions and supporting students to master those aspects of the curriculum they could achieve as they were (Markussen, 2004). This call to celebrate and accommodate diversity was a feature of the social model, which promoted the concept of disability as socially constructed (Culham & Nind, 2003; Liachowitz, 2010).

Rights-based Models and Approaches

Social versus medical models of disability. Whereas normalisation sought to integrate people with intellectual disability into mainstream society (Wolfensberger, 1980, 2011), and Conductive Education focused on the integration of children with physical impairments (Wright, Boschen, & Jutai, 2005), another rights-based influence on educational access commitments originated with the United Kingdom’s Union of the Physically Impaired against Segregation (UPIAS), whose Fundamental Principles of Disability argued disability as an entirely socially imposed category on top of impairment – the result of environmental barriers and practices of exclusion (Davis, Finkelstein, Finkelstein, & Hunt, 1976). The term ‘social model’ was coined in the 1980’s by Mike Oliver, as a way of expressing society’s negative contribution to the experience of having an impairment; “the oppression and discrimination of disabled people by institutional forms of exclusion and cultural attitudes embedded in social practices” (Terzi, 2004, p.141). According to this model, society disabled people with impairments both actively and passively – there would be no disability if societies properly catered for all citizens (Oliver, 2013). Within the social model, disability was not a personal attribute, but a “constructed category”, involving experiences of exclusion arising from mainstream practices that unjustly created barriers for some (Lamb, Jackson,

Walstab, & Huo, 2015, p. 3; Macauley, Deppeler, & Agbenyeger, 2016). It was argued that a “more helpful and respectful lens” was to see all people in terms of diversity, abilities, and rights (Rohwerder, 2015, p. 5; WHO, 2002).

The term ‘individual’ or ‘medical’ model, coined at the same time by social model proponents, referred to the contrasting position equating disability with individual impairment, and prioritising the use of medicine, rehabilitation and therapy to improve the ability to function in ‘able-bodied’ society (Anastasiou & Kauffman, 2011; Lindsay, 2003; Oliver, 1990; Shakespeare & Watson, 2001). The medical model was defined as locating disability entirely within the individual as an unwanted, personal deficit (Dalkilic & Vadeboncoeur, 2016). Social model proponents opposed such one-sidedness, particularly its presence in special education, where the implication was that to integrate, the child must adjust, with support, to existing school and classroom practices that did not need to change (Reindal, 2008; Slee, 2006, 2008). Normalisation and Conductive Education were equated to the medical model because of their emphasis on changing the child, and were therefore increasingly seen in negative terms (Culham & Nind, 2003; O’Rourke, 2015), though social role valorisation theory did not attend exclusively to within-person disability factors (Wolfensberger, 1995), and medicine and rehabilitation services had for many years followed a “causes to outcomes” framework that recognised the impact of multiple factors on functioning, even while engaged in “common-sense” interventions and individual capacity development (Kostanjsek et al., 2011, p. 1476; Low, 2001).

The result of the social model’s rights-based challenge was the instatement of a social constructionist ontology as the dominant paradigm for understanding disability in education (Wasserman, Asch, Blustein & Putnam, 2016) and critique of intervention as deficit-oriented (Anastasiou & Kauffman, 2013; Loreman, Forlin, Chambers, Sharman, & Deppeler, 2014; Macauley et al., 2016; O’Rourke, 2015; Slee, 1996, 2008; UNESCO, 2016). However, the

social model has also been critiqued for failing to acknowledge aspects of disability that are “physically grounded”, or biomedical in origin, including their personal impact (Bickenbach, Chatterji, Bradley, & Üstin, 1999, p.1176; Dalkilic & Vadeboncoeur, 2016; Lindsay, 2003; Low, 2001, 2006; Newell, 2010; Reindal, 2008; Shakespeare & Watson, 2001). This has been called an “over-socialised” position (Terzi, 2004, p.152) with an “excluded middle”, providing either social or medical explanations for disability, but not a more helpful combination (Shakespeare & Watson, 2001, p.19). In relation to students with physical disability, a singular focus on eliminating barriers and providing assistance in the classroom risked disempowerment if support was not also given to independent performance on tasks where physical functioning could be developed (Asbornslett & Hemmingsson, 2008) – tasks that were part of the occupation of student, and that provided opportunities to ‘do’, and to learn from doing for those requiring more intensive practice (Armstrong, 2012; Coles & Zsargo, 1998; Ferre, 2015; Gordon, Schneider, Chinnan & Charles, 2007; Hammell, 2015; Houwen et al., 2014; Latash, 2007; Latash & Anson, 1996; Morgan, Novak & Badawi, 2013). Social model proponents opposed health interventions seeking to reduce impairment and develop capacity on the basis that these contained ableist notions of normality that oppressed people with disability and opposed their desires for societal, rather than personal, change (Kunc, 2014; Oliver, 1989; Read, 1998; Shakespeare & Watson, 2001). According to this view, “ideas of prevention and cure (were) anathema and the term ‘rehabilitation’ suspect” (Low, 2001, p.14). However, it is a contention of this investigation that this equates capacity-development with deficit-remediation, rather than with an educational approach focused on facilitating knowledge and skill advancement (Griffin, Murray, Care, Thomas, & Perri, 2010). In the case of students with physical disability, if motor learning is given no curricular expression, and motor learning opportunities are removed, such advancement is less likely to occur (Gee, Graham, Sailor & Goetz, 1995; Heah, Case, McGuire, & Law,

2007; Hunt, Soto, Maier, & Doering, 2003). Therefore, it has been argued that educational settings need to support both equitable access and capacity-development (Low, 2001; Shakespeare & Watson, 2001).

In summary, medical and social models expressed polar ends of response to disability, indicating a need for more combined approaches (see Table 2).

Table 2 *Comparison of Social and Medical Models*

Aspect	Social model	Medical model
Impairment	An aspect of human diversity	An individual, observable deviation from biomedical norms
Disability	Negative interaction between a person's functional requirements and environments that do not take those into consideration	Inability to perform and participate in normative areas of life in the same way as others, or to the level expected or required, due to impairment restrictions
Cause of disability	Societal attitudes and practices of exclusion	Disease, trauma or other health condition
Action required	Social change, political lobbying and legislative effort to change structures and policies, and ensure access at all levels	Funding and provision of medical care and rehabilitation and other interventions to improve health outcomes
In education	Regular schooling for all – ensuring all aspects are accessible; design learning and teaching and support arrangements to help all succeed; focus on 'strong' functions	Mainstream education for those able to manage and learn in standard environments, provision of special education alternatives; remedial education; strengthening impairment-impacted areas

Combined rights-based models. Integrated, twin-track disability models have navigated competing claims (Altman, 2001), and potentially may offer better support to educational capacity-development concerns than either medical or social models. Twin-tracking was originally developed to support gender equality in development projects, as equal access for women was found to be insufficient without capacity development enabling them to step into the new opportunities created for them (DFID, 2000; Rushford & Thomas, 2015). Two twin-track examples that recognise the impact of both within-person and environmental factors in

disability experience, and the need for their “compensatory interaction” (Lindsay, 2003, p. 5; see also Anastasiou & Kauffman, 2013; Curtin & Clarke, 2005; Department for International Development, 2000; Lindsay, 2007; UN, 2012), are the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001) and the Capabilities Approach (Nussbaum, 2011a; Robeyns, 2003; Sen, 1979, 1992). These will be explored in turn next, for their contribution to supporting learning and skill development.

The International Classification of Functioning, Disability and Health (ICF). The ICF was developed to classify health-related functioning in life situations (Kostanjsek et al., 2011; WHO, 2001). Its multifactorial presentation of health as “biopsychosocial” took seriously the biological, individual and social components of health and illness, describing disability as an “umbrella term” for the “dynamic interaction between a person’s health condition, environmental factors and personal factors” (Palmer & Harley, 2012; Rohwerder, 2015, p. 6; WHO, 2013). This biopsychosocial view of health expanded the way disability was understood, no longer drawing sharp distinctions between it and health, and between disabled and non-disabled people (Ferguson, Jelsma, Versfeld, & Smits-Engelsman, 2014; Jette, 2009). Disability was presented as a normal part of life, including temporary states of reduced function arising from illness or accident, as well as more permanent conditions (Foreman & Arthur-Kelly, 2014). The rights-basis for the model was evident in this acceptance of variation and difference in ability as part of normal diversity, and the encouragement of ‘self-defined’ goals and their achievement in whatever way worked best for the individual (McDougall & Wright, 2009; Raghavendra, Bornman, Granlund, & Björck-Åkesson, 2007). At the same time, disability continued to be measured by normative standards in relation to what constituted health and what kinds of activities and participation were to be expected (WHO, 2007).

According to the ICF, functioning was considered along a continuum, with disability describing both health conditions at body function and structure levels, as well as activity limitations and participation restrictions attending those conditions to different degrees, depending on individual situations and contexts (Rimmer, 2006; Stucki, 2005). The argument of the ICF was that functioning and disability could not be deduced linearly from health conditions or impairments alone, as in practice, the interplay of the individual's environmental and personal factors with their condition was "complex, dynamic and often unpredictable", and the associations needed to be empirically explored and not assumed (WHO, 2001, p.4). Specifics of the health condition, as well as influencing contextual factors, were to be considered together in assessment and intervention (Chien & Brown, 2017; Doucet & Gutman, 2013; Hocking, 2001; Weinstock-Zlotnick & Hinejosa, 2004). The ICF components and their relationship were illustrated in a conceptual framework, depicted in Figure 1 (WHO, 2001), which demonstrated the requirement to describe impairments not only at the body level but in terms of activity and participation.

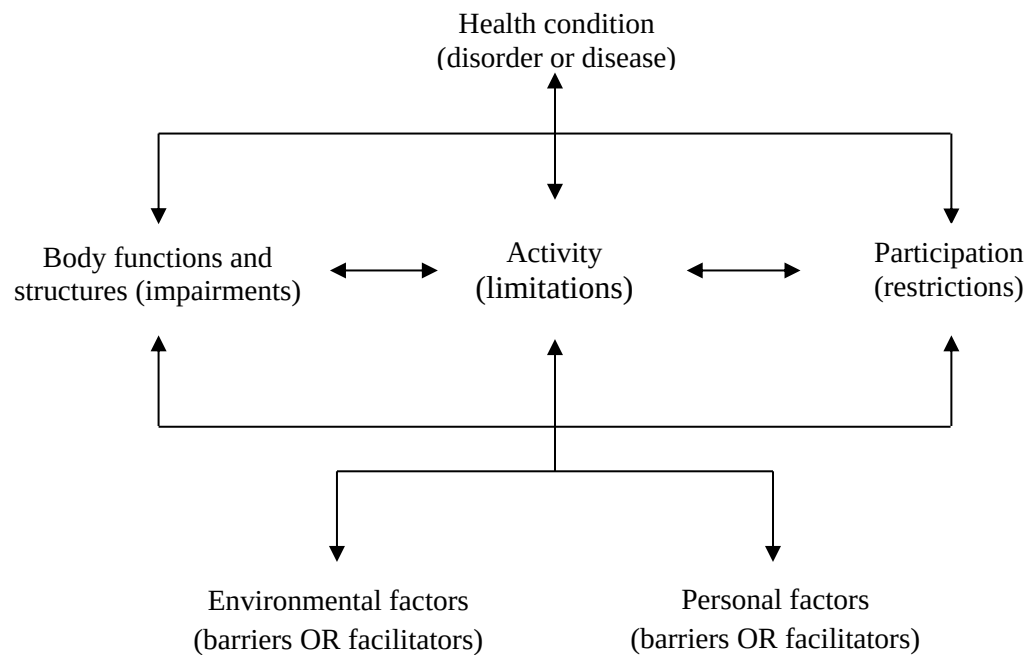


Figure 1. ICF components (WHO, 2001, p.18)

The nine activity and participation domains provided by the model were designed to cover all aspects of life and were ordered from single elements to their nesting in larger life areas:

1. Learning and applying knowledge
2. General tasks and demands
3. Communication
4. Mobility
5. Self-care
6. Domestic life
7. Interpersonal interactions and relationships
8. Major life areas (including education)
9. Community, social and civic life

Each of these domains were further divided into sub-components for convenience to the end-user. In considering an individual's functioning in a major life area, the set of sub-

components that best represented critical aspects of their performance were the assessment focus (WHO, 2013). Understanding a student's ability to achieve the motor-related requirements of classroom functioning, for example, would involve consideration of the following sub-components of domains 1-5:

1. Learning and applying knowledge:
 - Purposeful sensing – touch,
 - Basic learning – through actions with objects and engagement in play,
 - Applying knowledge – physical use of writing implements/ technology;
2. General tasks and demands:
 - Undertaking classroom tasks,
 - Carrying out routines;
3. Communication:
 - Producing nonverbal messages,
 - Using communication devices;
4. Mobility:
 - Changing and maintaining body position,
 - Carrying, moving and handling objects,
 - Walking and moving;
5. Self-care:
 - Looking after one's (physical) safety in shared space.

Impairment, performance level, and barriers in relation to each of these areas were considered separately and recorded using a 5-point, generically qualified rating scale (0 = no impairment, difficulty or barrier; 4 = complete impairment, difficulty or barrier). The result established the various contributors to motor-related educational difficulty.

The ICF was not developed as a classification of educational functioning but to connect health functioning to the requirements of life settings, including education. In educational settings, it was proposed as a “neutral bridge” between disability, development, social-dynamic and curriculum-related assessments, enabling greater understanding of the contextual factors influencing student difficulties and what should be optimally targeted (WHO, 2001, p.68). Administratively, it supported education systems in their decision-making around eligibility and service provision based on classroom functioning, rather than on diagnostic categories (Hollenweger, 2011a; Simeonsson, 2009), though an unofficial expansion, shown in Figure 2, has been proposed to better enable its educational use.

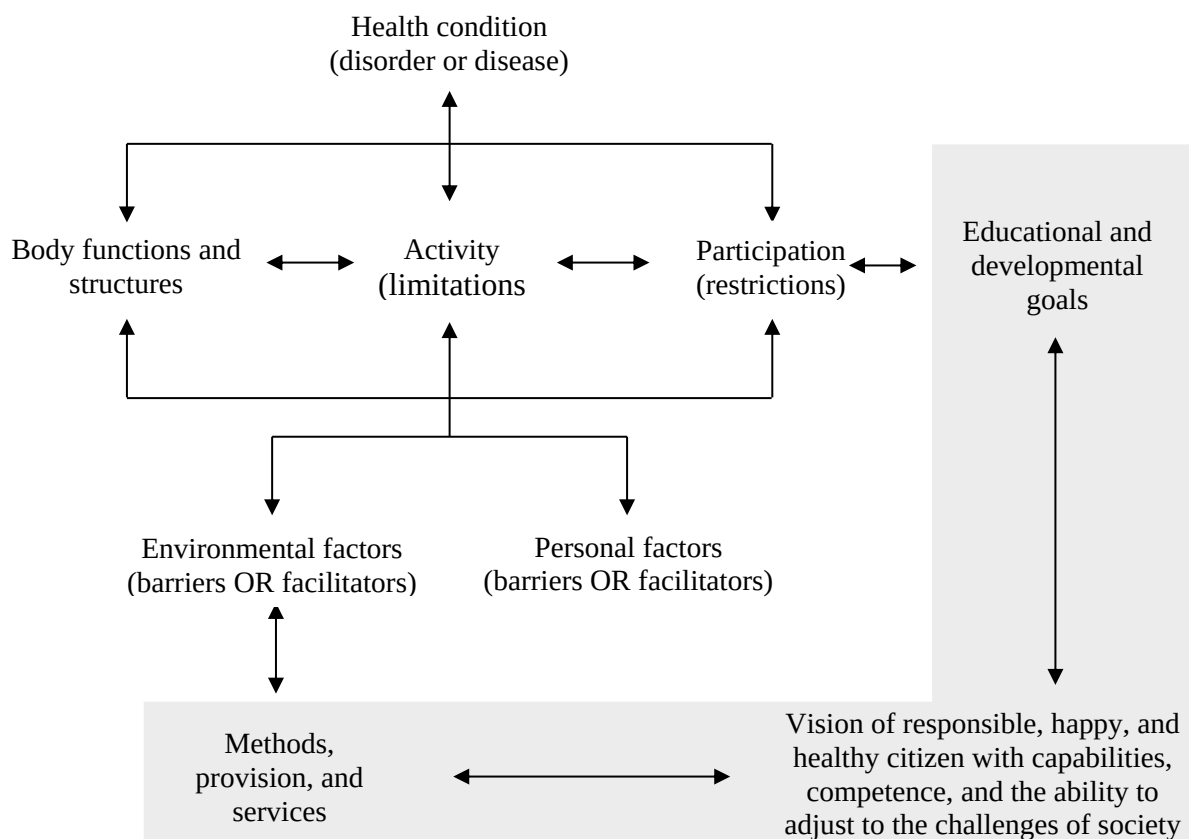


Figure 2. ICF expansion incorporating educational goals (Hollenweger, 2011a, p.5).

Reviewing the ICF, firstly, it measures health functioning against normative standards, which impacts projections about future functioning (Reindal, 2016). Normative benchmarking has been associated with conclusions that do not consider individual situations,

and remain focused on within-child impairment factors, such as Singer's (1994) perspective in relation to the education of children with Down syndrome –

...we cannot expect a child with Down syndrome to play the guitar, develop an appreciation of science fiction, learn a foreign language, chat with us about the latest Woody Allen movie, or be a respectable athlete, basketball player or tennis player.

(Singer, 1994, p.213).

The consequence of using such normative-benchmarking approaches in education may be the shutting down of possibilities for children with disability, based on the way they have been assessed and the activities deemed appropriate for them.

Secondly, the need for Hollenweger's (2011a) unofficial expansion of the ICF to facilitate its use in education highlights three educationally-related concerns:

1. Resources and service provision also determine functioning in educational settings, so require tabling.
2. A classification of current functioning does not fully capture education's future focus, and concerns for expansion and development of current functioning through activities of teaching and learning.
3. A neutral classification that presumes self-defined goals and modes of achievement does not fully capture the more compulsory nature of educational goals, and the more targeted, future focused nature of the educational setting. For example, the descriptive nature of the ICF may result in the physical requirements of the classroom being seen only as excluding constraints to work around. Rather, classrooms contain curricular expectations and are educationally "interventionist settings" (Hollenweger, 2011a), as also noted by Article 24 of the *Convention on the Rights of Persons with Disabilities*, which states that education must aim for

“the development of personality, talents and creativity, as well as mental and physical abilities, to their fullest potential” (UN, 2006, Article 24, ohchr.org).

In summary, the ICF is a comprehensive framework that connects health and health conditions to domains of human life and functioning, providing a picture of current functioning and its sources. In educational settings, it provides a bridge between specific assessments of the student by different members of the support team, and aids identification of contextual factors impacting student performance. However, its neutral and current functioning focus does not fully capture the compulsory, learning-oriented and future-focused nature of school-based education, nor support appraisal of classroom environments and tasks for their learning and capacity development potential.

The Capabilities Approach. The Capabilities Approach was conceived by Amartya Sen, not as a disability model, but as a theory of distributive justice concerned with equality of outcomes rather than means – the extent to which a person was free to pursue the life they valued (Sen, 1979). Two core concepts were “functionings” and “capabilities” (Drèze & Sen, 2002, p.35; Terzi, 2008):

- Functionings referred to all the activities and desirable end states a person achieved in their life in terms of doing and being, covering innumerable and diverse options, such as reading, playing sport and being educated.
- Capabilities were the real options and practical opportunities people had to act upon the world and achieve alternative combinations of these functionings as they desired (Sen, 1985; see also Cauce & Gordon, 2012). As the capability set (real and available choices and opportunities) determined what was possible, capability expansion was the goal (Terzi, 2014). Thus, the Capabilities Approach challenged the “vertical inequality” resulting from approaches to meet the needs of vulnerable groups that

failed to provide for this expansion (Terzi, 2008, p.178; see also Sen, 1993; Taylor, 2012).

Figure 3 depicts the interconnection of concepts in the approach, demonstrating how the commodities available to a person, alongside the relevant aspects of their environment and personal characteristics, influenced what was in their capability set, from which their functionings developed as a subset of the capabilities they chose to achieve.

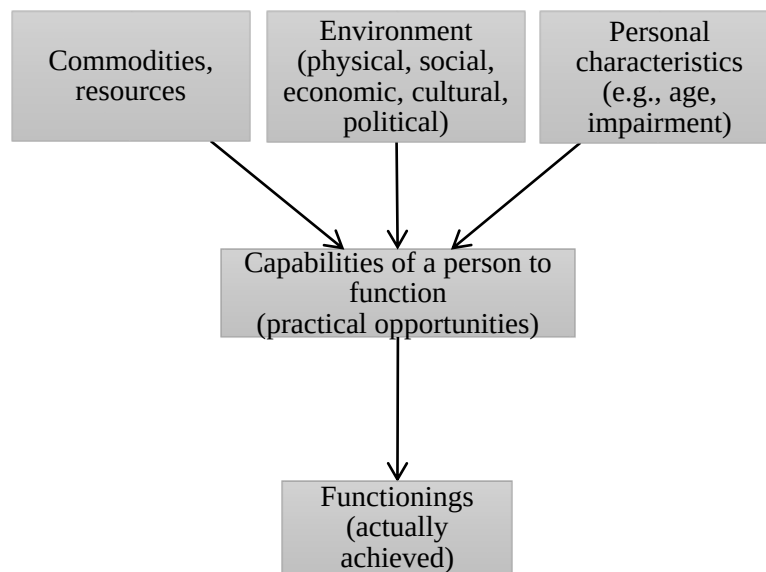


Figure 3. Relationship of concepts in the Capabilities Approach ((Mitra, 2006, p.239)

Capabilities were not exhaustively defined, being constituted as all the goals people might consider valuable, however, mention has continued to be made of access to educational opportunity and knowledge expansion, both for their intrinsic benefit to wellbeing and flourishing, and their instrumental allowance for an expanded capability set (Fukuda-Parr, 2003; Norwich, 2010, 2014; Robeyns, 2006). In addition, ‘personal characteristics’ have not been definitively unpacked, including disability (Nussbaum, 2011b). Difficulty with operationalization has been connected to this under-specification, and the risk of sources of injustice remaining implicit because they have not been named, although it has also been noted that retaining a wide evaluative scope around a person ensured no discriminating

practices were missed through a ‘tick-box’ approach (Robeyns, 2006). Concern about its use in education has been related to operationalising difficulty due to its radical under-specification (Alkire, 2008; Fukuda-Parr, 2003; Robeyns, 2006). For these reasons, the usefulness of the Capabilities Approach has been seen in the complementary insights it offers with regards to health and human potential, rather than providing an alternative to other approaches. In summary, the Capabilities Approach challenges the service systems of society, including education, not to be content with following rules or meeting minimal legal requirements if genuine expansion of capabilities for vulnerable citizens is not also achieved (Reindal, 2016; Robeyns, 2006). In relation to students with disability, this includes interrogation of the curriculum, to determine the extent to which it can be tailored to maximise functioning possibilities for the individual child (Terzi, 2014). The focus on capabilities also directs attention to future potential with the right resourcing now and, as such, it accords with the nature of education as capacity-developing and future focused. However, its under-specification means application is at the level of overarching critique and complementary insight to current educational practice.

Summary of Declarations, Movements, and Models

The preceding section has made the following points:

- International rights-based declarations have advocated that schools accommodate all learners, and the right to individualised learning opportunities from teachers adequately trained to provide this.
- International calls for quality education and curricula capable of being differentiated have been reflected in part in the work towards an Australian national curriculum that has included policy level commitments to inclusion in its curriculum framing documents.

- A focus on capacity-development in impairment-related areas has been a contested topic. However, when seen as part of curricular learning, rather than as deficit remediation, this need not warrant an ableist critique. Instead, it provides an example of differentiated, or personalised, learning and capabilities realisation for students with particular learning needs, such as in the area of classroom-related movement.
- The social model has helpfully highlighted the impact of environmental barriers on disability experience; however, its critique of rehabilitation may also overlook impairment-related learning that builds capabilities.
- Interactional disability models such as the ICF and the Capabilities Approach have recognised disability's emergence from the interaction of impairments, environments and tasks. These twin-track approaches both challenge social barriers and affirm the importance of individual capacity-development. In relation to their use in education, the ICF focus on *current* health functioning, and reference to *typical* norms and standards, varies from the *future* and *individualised* focus of education, while the Capabilities Approach offers high-level critique to systems whose support of people with disability falls short of capabilities realisation, and, in education, has promoted the right to tailored instruction that supports curriculum access. It does not, however, provide an operationalizable construct.

International and National Legislation

The second main driver for improving the education of students with disability is the passing of anti-disability discrimination legislation (Foreman, 2015). This section of the current chapter will focus primarily on legal frameworks supporting disability considerations in education in Australia, prefaced by summaries of influential United States and United Kingdom legislation, countries with strong political and cultural connections to Australia (Handley, 2001). The varied, regional-led nature of educational access commitments in

Canada (Winzer & Mazurek, 2011, 2012), which manages education at the provincial, rather than federal level (Jahnukainen, 2011; Jenkinson, 2002; Winzer, Altieri, Jacobs, & Mellor, 2003), is similar to Australia.

The United States

In the United States, the civil rights movement contributed to legislative change for children with disability. Advocates for disability rights campaigned for anti-discrimination legislation using the platform of the social model, arguing that the removal of excluding environmental and attitudinal barriers must be secured legally (Dempsey, Foreman & Jenkinson, 2002; Handley, 2001). Their work supported the development of the Education for All Handicapped Children Act (1975), revised in 1990 as the Individuals with Disabilities Education Act (IDEA), and reauthorised in 2004 as the Individuals with Disabilities in Education Improvement Act (IDEIA 2004) (United States Code Annotated, 2004). This was federal law that secured the right of children with disability to be educated, to access the regular curriculum, and to receive an Individualised Education Plan (IEP) and allied health professional support (Foreman, 2015; Poed, 2015). It distinguished between academic aspects of a school program and non-academic “school function” aspects – functional skills that supported or enabled participation in academic learning.

The United Kingdom

In the United Kingdom, the Warnock Report (1978) challenged the idea that disability required special educational provision and called for all children with “special educational needs” (SEN) to be educated in non-segregated settings (Armstrong & Barton, 2007, p.9). The Education Act (1981) legislated for the concept of special educational needs, which became a rapidly expanded mega-category, made up of non-diagnosed learning difficulties in addition to disability. The passing of the *Special Educational Needs and Disability Act* (2001) accorded the right of students with SEN to be educated in regular school settings,

provided efficient education of other students could be ensured – an escape clause that lessened the power of the Act (Foreman, 2015). Strengthened legislation occurred in 2004 through the Removing Barriers to Achievement Act, and in 2010 with the Equality Act, though no statutory requirement for IEPs was made (DfES, 2004). As a result, there now exists in England legislation that make discrimination at any point of education unlawful. However, Armstrong and Barton (2007) have noted the complexity of enacting this legislation in educational contexts that remain at the same time committed to standard ideas about normality and difference, and that must also respond to international calls and increased government pressure to lift academic standards (Warnock & Norwich, 2010).

Australia

Australian legislation in relation to education of students with disabilities includes the *Disability Discrimination Act* (1992), and its subordinate legislation, the *Disability Standards in Education* (2005). In addition, each state has its own anti-discrimination and equal-access <https://i2.wp.com/workshop.electronsmyth.com/wp-content/uploads/2015/01/Flash-Comparison.jpg> legislation, for example in Victoria, the Victorian Equal Opportunity Act (2010) and Victorian Education and Training Reform Act (2006), and in New South Wales, Australia's most populous state, the Anti-Discrimination Act 1977 (NSW), last amended 2009, and the Disability Inclusion Act 2014. There are also now national *Professional Standards for Teachers*, which set out teacher requirements in relation to supporting the full participation of students with disability (AITSL, 2011). Each of these levels of legislation will be examined in turn.

The Disability Discrimination Act 1992 (DDA). The 1992 Australian Disability Discrimination Act (DDA) (Australian Attorney-General's Department, 1992) made it unlawful for schools to deny enrolment or access to adequate education to students based on disability (Jenkinson, 2001). The DDA is not a comprehensive legal framework, but anti-

discrimination legislation that sets out how to deal with discrimination once it has occurred. Essentially, it is a “passive tool”, prohibiting discrimination (Guthrie & Waldeck, 2008, 134), but lacking specification that may still mean discrimination occurs, for example in relation to the *quality* of participation that meets the demands of inclusion.

In the DDA, disability is defined broadly to include physical, sensory, cognitive, psychiatric and neurological conditions, complex and challenging behaviours, disabilities of past and future existence (catering for such as intermittent conditions), and family members of people with a disability, who face discrimination for that reason. Discrimination in education on grounds of disability is unlawful – whether through restricting enrolment policies, detrimentally alternative treatment while in school, or inaccessible school environments or curricula (Australian Attorney-General's Department, 1992). Again, an escape clause is included, allowing schools a plea of unreasonable hardship alongside a compliance model where breaches are not penalised until formal complaints are made, with the onus of proving discrimination remaining with the complainant until this has been established (Guthrie & Waldeck, 2008; Jenkinson, 2001; Poed, 2015).

Disability Standards in Education 2005 (DSE). Following numbers of cases being brought for resolution around differing interpretations of unjustifiable hardship, the Commonwealth Government in 2005 passed the *Disability Standards for Education* (DSE) to “clarify and elaborate the legal obligations” relating to the education and rights of students with disability (Commonwealth of Australia, 2006, p.5). The DSE covers the main schooling aspects of enrolment, participation, curriculum development, provision of services, and harassment and victimisation. It includes the concept of “on the same basis”, in relation to requirements that the curriculum be developed and delivered in such a way that students with disability receive reasonable educational adjustments and guaranteed participation in learning (Commonwealth of Australia, 2006, p.11).

In 2011, the Australian Government's Department of Education, Employment, and Workplace Relations (DEEWR, 2012) undertook a review of the first five-years of the DSE, with results noting issues with interpretation, application and adherence to requirements, particularly:

- ongoing instances of exclusion, discrimination and reduced participation,
- lack of advice, resourcing and training/ professional development for teachers and teacher assistants,
- inconsistent development of positive and achievable Individualised Education Plans (IEPs) and differentiated curricula catering for student requirements (Victorian Auditor-General's Office, 2012), and
- limited access to health professionals (Commonwealth of Australia, 2012).

Recommendations were headed by a call for better quality teaching and inclusive curricula (Commonwealth of Australia, 2012; Haythorpe & Hopgood, 2015). In response, extra funding to government, independent, and Catholic education authorities in each state and territory enabled one-off projects to be undertaken (Educational Council, 2016) and a new data collection mechanism – the *Nationally Consistent Collection of Data on School Students with Disability* (NCCD_SWD) to be developed (Australian Government Department of Education and Training, 2016).

In the following five-year review, “innovative and responsive learning strategies for students with disability” were again targeted for further work (Urbis Public Policy Team, 2015, p.4), while review panellists continued to express confusion over the concept of inclusion – did it merely mean location in the classroom, or involve enabling students to achieve at their full potential? This question reflected both awareness and concern about the more demanding inclusion concept of educational *quality* and that this would fail to be achieved if it was collapsed into the simpler concept of inclusion as merely *access*, or

presence, in the same space. Slee (2013) has described an ongoing situation of “children at the back of the classroom protected and taught by adult assistants” (p.905), in other words, those with the greatest educational needs being educated by those least equipped to teach them. Overall, despite policies and regulations, difficulties achieving educational equity have continued, with most recent reports noting ongoing dissonance between policy and school practice and continuing to call for better quality teaching (Australian Government DET, 2018; Commonwealth of Australia, 2016).

Teacher Professional Standards 2015. Another related Australian response was the development of the *Australian Professional Standards for Teachers* (AITSL, 2011) to support the requirements of the Melbourne Declaration (2008). Teacher quality is crucial to good student outcomes, with teachers viewed as “primary agents” in educational access commitments (Subhan & Sharma, 2006, p.43; see also Hattie, 2003; Lindsay, 2007; Wakeman, Browder, Meier & McColl, 2007). Incorporated into these standards, focused on lifting teacher quality, are requirements for proficiency in accessible education principles and practices, including abilities to assess/diagnose student stage of learning, use assessment data to differentiate teaching practice to meet specific learning needs, and ensure that what is taught through the curriculum supports quality learning outcomes for all students. These aspects of quality teaching – differentiated instruction using data from formative assessment, and provision of an inclusive curriculum – constitute important research-based instruction and teaching methods for students with disability, as for all students. Findings from research in relation to these aspects will be discussed in the next section, prefaced by scholarly insights about intact learning ability in the context of disability.

Research Findings

All Children Can Learn, Providing Teachers are Equipped to Teach All Children

Foundational to commitments to develop capacity in impairment-related areas is the belief in the capability of all children to learn (Malcolm, 1993; Shepard, 2000; Wills, Morton, McLean, Stephenson, & Slee, 2014). This is consistent with social-constructivist learning theory, inspired by Vygotskian insights. Vygotsky saw learning as an active, socially mediated process, and possible for all students through provision of scaffolded support pitched optimally (Vygotsky, 1978; see also Glaser, 1981; Shepard, 2000; Wood, Bruner, & Ross, 1976). This perspective challenged earlier nativist views of fixed intelligence and innate ability that influenced the withholding of curriculum from certain student groups, including those with disability (Shepard, 2000).

Intellectual disability and academic learning. In relation to learning capacity in children with intellectual disability, an accepted assumption prior to the 1970s and the passing of the United States *Education for All Handicapped Children Act* in 1974 was that this was low or absent, with special education labels such as “untrainable and uneducable” emphasizing this assumption (Gartner & Lipsky, 1987, p.369). Students so labelled were allocated to functional curricula and prevented from accessing the academic input presumed to be beyond them (Wehmeyer, Lattin & Agran, 2001). Because disability was viewed as a within-individual state that was innate, static, and fixed, special school curricula had as much to do with choosing knowledge and skills to withhold as to teach. The resulting content has been described as academic “non-knowledge”, consisting largely of social skills training, behaviour modification, and child-minding (Tomlinson, 1982, p.135; Agran, Alper & Wehmeyer, 2002; Wehmeyer et al., 2001). This content was critiqued in the 1970s in the United Kingdom by the Warnock Committee, who proposed that student abilities in special schools were being underestimated and poorly served by a narrow, poor-quality curriculum

(Warnock, 1978). Other authors noted the problem of a society-wide attachment to a “functionalist paradigm” that incorrectly assumed a single source for school failure/problems in the individual student (Pazey, Heilig, Cole, & Sumbera, 2015, p.371; see also Baker & Zigmond, 1995; Graham & Jahnukainen, 2011). Such assumptions of fixed incapacity also failed to consider Vygotsky’s proposal of evident learning potential in the adaptive, compensatory abilities of children with disability to “proceed by roundabout ways” when blocked by society (Vygotsky, 1993, p.32). Vygotsky argued that the education of children with disability should focus on this potential and assist the roundabout paths of development to proceed successfully. He noted that disability was not fixed, but that growth and learning remained possible for every learner with proper assistance. Vygotsky’s “zone of proximal development” (ZPD) concerned the relationship of instruction to student development (Vygotsky, 1993, p.17; 1978; see also Chaiklin, 2003). It proposed there were zones of maturing functioning between qualitative transitions in learning, and that instruction tailored to these zones could effectively draw student learning forwards. Vygotsky believed education led development in a qualitative and transformational process, rather than one that was linear and straightforward. This required teachers to identify each student’s ZPD, particularly those experiencing difficulties (Gindis, 1999).

A number of studies have provided empirical evidence of the capability of students with moderate to severe intellectual disability to learn academic content (Browder, Spooner, Wakeman, Trela, & Baker, 2006; Browder, Wakeman, Spooner, Ahlgrim-Delzell, & Algozzine, 2006; Coyne, Pisha, Dalton, Zeph, & Smith, 2012; Gersten, Fuchs, Williams, & Baker, 2001; Kroesbergen & van Luit, 2003; Ryndak, Jackson & White, 2013). In keeping with this, and in response to growing disability rights requirements in relation to education, the United States’ No Child Left Behind Act (2002) prompted a shift in the education of students with disabilities from a focus on functional skills to a “mandate for providing access

to the (academic) general education curriculum” (Whinnery, Whinnery & Eddins, 2016, p18; see also Hunt, McDonnell, & Crockett, 2012; Knight, Browder, Agnello, & Lee, 2010).

Teachers became responsible to ensure both access to, and progress in, the academic curriculum for students with disabilities. Given the time constraints of learning in general education settings, an either-or option between academic and functional skill development was often the result (Hunt et al., 2012).

Physical disability and motor learning. Assumptions of incapacity were also earlier held about the ability of students with physical disability to learn motor skills. At one level, physical disabilities are lifelong conditions, and levels of performance incapacity reflect impairments to musculoskeletal, neurological, and/ or other bodily systems that learning cannot eliminate (Kielhofner, 2008; Rosenbaum, 2014). However, an over-focus on deficit areas has also contributed to inaccurate clinical assumptions, as recently as the 1990s, that people with physical disability had little or no capacity to learn motor skills (Shepherd, 2013). One ongoing outcome of this thinking is that the movement demands of classroom learning constitute barriers, not learning opportunities. This presents some complexity, as in many cases, removal of obstructive barriers is necessary and, from the perspective of the social model, barriers in the environment are causative factors. Unmodified physical infrastructure increases the need for adult support (Egilson & Traustadottir, 2009a), and tasks with high motor demand, within curricula “overloaded with academic content” (Curtin & Clarke, 2005; Pitt & Curtin, 2004; UNESCO, 2009, p.15) and lessons requiring completion in narrow time constraints, tax finite resources and result in lowered motor and academic achievement, and loss of confidence and motivation (Cameron, Murrah, Grissmer, Brock, Bell, Worzalla, & Morrison, 2012). School-based occupational therapists continue to play a significant role in identifying and advising removal of these barriers and in maximising academic participation within disability constraints (Hinder & Ashburner, 2010).

However, removing physical elements without considering their role in motor skill development can mean important, natural movement learning opportunities embedded in everyday classroom tasks and activities are overlooked and secondary disabilities such as decreased motivation and overdependence become more likely (Cameron et al., 2012; Effgen, 2013; Goldstein, Cohn & Coster, 2004; Marr, Cermak, Cohn & Henderson, 2003; Missiuna & Pollock, 1991; OTA, 2012). This practice is also not in keeping with the UNESCO (2009) policy guidelines for individualised curriculum and personalised instruction approaches, nor the call for capabilities expansion of the Capabilities Approach (Terzi, 2014). In connection to this, Adolph and Berger (2006) have highlighted the contribution of practice to maximised physical functioning, noting the example of typically developing children who take, on average, 9000 steps a day, and experience 15 inconsequential falls an hour (see also Effgen & Chan, 2010). Gibson et al.'s (2009) clinical commentary on therapy assumptions in paediatric rehabilitation has noted a “false dichotomy” between the traditional focus on “fixing”, including capacity development in impairment-related areas, and the concern to enhance “functioning” by eliminating task and environmental barriers and providing workarounds to absent or insufficient skills (p.1447). Instead, a combined approach has been recommended, that includes capacity development, but does not ignore the need to restructure environments and tasks to remove barriers and maximise participation (see also Doucet & Gutman, 2013; Weinstock-Zlotnick & Hinejosa, 2004). These barriers include not only environmental and task aspects beyond the student's capacity, but lack of safe environments in which to move freely and explore and over-protective restrictions preventing opportunities for physical decision-making, healthy risk taking, and effortful striving to achieve (Missiuna & Pollock, 1991). In support of these kinds of learning provisions at school, physical rehabilitation research has indicated many intact motor learning capacities within the constraints of disability, and highlighted the importance of individualised instruction, task-

oriented training, intensive practice, and the use of natural tasks and settings to maximise learning gains (Armstrong, 2012; Carr & Shepherd, 2006; Charles & Gordon, 2007; Effgen, Chiarello, & Milbourne, 2007; Ferre, 2015; Gordon, Bleyenheuft & Steenbergen, 2013; Gordon et al., 2007; Houwen et al., 2014; Latash, 2007, Latash & Anson, 1996; Morgan et al., 2013; Shepherd, 2013; Thomason, 2015; Whinnery & Whinnery, 2007). Scholarly findings include:

- the reorganizational capacity of the animal brain when provided with challenging and task-specific training, which has elevated the importance of motor learning in rehabilitation (Plautz, Millikan, & Nudo, 2000; Winstein & Kay, 2015).

Consequently, brain imaging technology has also provided strong evidence that motor learning produces adaptive brain changes and that neural plasticity is experience-dependent (Kleim & Jones, 2008),

- causal links between level of motor performance and history of motor learning opportunities in children with cerebral palsy, alongside evidence that negatively adaptive changes to musculoskeletal systems through underuse can be prevented or reversed by task-oriented skill and strength training, and motor gains can be lost if practice is not regular and ongoing (Blundell et al, 2003; Carr & Shepherd, 2006; Damiano, Vaughan & Abel, 1995; Effgen, 2013). Also, in cerebral palsy intervention, improvements in motor function, including hand function and postural control, have been shown to result from intensive practice in natural settings (Gordon et al., 2013; Shepherd, 2013),
- improved academic performance and motor coordination in children with Developmental Coordination Disorder (DCD) following problem-solving and strategy training (Polatajko & Mandich, 2004) and functional skills training (Niemeijer, Smits-Englesman, & Schoemaker, 2007; see also Armstrong, 2012),

- improved motor skill learning arising from systematic adjustment of practice goals as learning proceeds, to continually maximise approximation to the intended motion (Castro, Monssen, & Smith, 2011),
- nervous system adaptability and improved motor capacity resulting from exposure to many, diverse movement experiences, according to Edelman's (1987) theory of neuronal group selection (see also Sigmundsson, Trana, Polman, & Haga, 2017),
- improvements in basic hand skills, head movements, and walking in children with severe or profound intellectual disability as the result of intensive intervention (typically daily, or 5 days/week) (Houwen et al., 2014),
- intact abilities of children with Down syndrome to learn functional motor synergies when provided with regular, variable practice (Latash, 2007), and to improve their independent walking following intensive treadmill training (five times per week for 10 months) (Ulrich, Ulrich, Angulo-Kinzler, & Yun, 2001). The benefits of group approaches to motor learning for this cohort have also been noted (LaForme-Fiss, Effgen, Page, & Shasby, 2009),
- brain injury recovery taking place in young children as the result of neuroplasticity and the provision of enriched environments (Morgan et al., 2013), and
- the large rehabilitation effects in animal studies with early, intensive rehabilitation regimes, over those making premature accommodations to impairment (Forsyth and Basu, 2014).

These studies also suggest the natural classroom setting as a fruitful site for motor learning, as this would support accurate performance appraisals by those knowing students well, daily interactions allowing scaffolded support to be constantly adjusted as learning proceeds, and regular opportunities to practise important skills when and where these are required (Hollenbeck & Miller, 2013; OTA, 2017). This view is also supported by the

overall developmental approach of the national Australian curriculum and its emphasis on instructing in the General Capabilities (ACARA, 2014b), which, in the Australian educational context, refers to undergirding foundational skills that facilitate academic learning. These capabilities include not only Literacy and Numeracy, but Personal and Social Capability, Information and Communication Technology (ICT) Capability, Ethical Understanding, Critical and Creative Thinking, and Intercultural Understanding. In an article explaining their development, Howes (2012) proposed the General Capabilities as important areas of general knowledge and skill that, though easily acquired “through a process of osmosis” for many students, should not be assumed incapable of being learnt by others (Howes, p.9). Instead, he argued these foundational skills should form an integral part of the curriculum, and be explicitly instructed using the same developmental learning, or curricular, approach (Price, 2015). Foreman and Arthur-Kelly (2014) have also discussed the importance of differentiating teaching to include, if necessary, atypical school content that is nevertheless “still learning (that) can be nurtured and developed by teachers and other staff in school settings” (p.11). They have noted there is no school system requiring all students to follow the same curriculum, and that progress in an “appropriately planned curriculum” should take precedence over one meeting standard grade-expectations (p.30). To achieve this differentiation, the Australian Curriculum, Assessment and Reporting Authority (ACARA) has proposed different degrees of focus on the General Capabilities, from using relevant ones to scale back demand in academic subjects, to making under-developed capabilities a more sustained learning focus (ACARA, 2014).

At this point, classroom-related goal-directed movement has not been included in the list of General Capabilities in the Australian Curriculum, and it is a purpose of this research to consider its classroom-related role along the lines of Howe’s (2012) necessary, atypical school content that forms a legitimate part of a curriculum that can be differentiated for

learning need. Numerous studies have shown that movement competency is a fundamental skill that supports cognitive and language development, classroom participation and performance, self-regulation, and play, and is particularly important for students who need targeted assistance to acquire it (Brossard-Racine, Hall, Majnemer, Shevell, Law, Poulin, & Rosenbaum, 2011; Houwen, Visser, van der Putten & Vlaskamp, 2016; Jennings, Connors & Stegman, 1988; Majnemer, Shevell, Law, Poulin, & Rosenbaum, 2010; Missiuna & Pollock, 1991; Varsamis & Agaliotis, 2015). This argument is also consistent with the Capabilities Approach that prioritises, as most educationally worthwhile, those knowledges and skills most likely to expand opportunities and freedom of choice (Price, 2015). In support of the relevance of classroom related movement competency to this broader set:

- Nussbaum (2003) has included in her ten central capabilities, bodily health, play, and control over the environment,
- Bailey (1984) has included in his “serving competencies” basic to education those of physical fitness and keyboard skills, the latter requiring fine-motor competency (p.80), and
- Terzi (2008), in her capability perspective on disability and special educational needs has included abilities to engage in activity, to exercise, and to play as critical to educational development.

In conclusion, it has been well established that growth and learning is possible for all students, including motor learning for students with physical disabilities, and there has been a world-wide movement to ensure curricular content does not only consider academic areas, but foundational skills required to achieve that learning, including relevant motor skills. This adds a further requirement to teacher instructional capability.

The equipping of teachers to teach all learners. The requirement of teachers to individualise curriculum and instruction for the learning needs of students with disability raises the question of the adequacy of pre-service training to meet this requirement. As already stated, of all educational factors, policies and programs, teachers have the greatest impact on student learning (Ashman, 2010; AITSL, 2011; Hattie, 2003, 2008; Neal & Eckersley, 2014). However, surveys of current teachers and insights from educational research have noted inadequacies in pre-service teacher training and resourcing in relation to disability inclusive practice (Australian Education Union, 2015; Dempsey, 2012; Education Council, 2016; Hollenweger, 2011b; Ingvarson, Beavis & Kleinhenz, 2004; Parliament of Victoria, 2005; Sharma, 2014; Thomas, 2007; Urbis Public Policy Team, 2015; Victorian Auditor-General's Office, 2012; Victorian DET, 2016; VEOHRC, 2012). Of interest to this study is the extent to which classroom-related motor learning needs for students with physical disabilities are considered in pre-service teacher training. Health professionals working in educational settings have noted a lack of teacher attention to motor development in classroom settings, which they consider understandable given the minimal training and curriculum resourcing teachers receive to intersect with this area (Effgen & Chan, 2010; see also Ayres, 1999; CEC/DEC 2007; McDonald et al., 2001; VEOHRC, 2012). Academic goals are naturally prioritised, as already noted, consequently it is not surprising that much classroom time is sedentary, and there is an emphasis on moving children quickly between activities. Excessive dependence of students with physical disabilities can result from this practice, however; for example, one study noted four dependent transfers per hour occurred in a preschool classroom, when what was needed was more independent transfer opportunities (Ott & Effgen, 2000).

There is a lack of research on the educational input generalist classroom teachers receive to support motor learning needs. To gain some appreciation of what was available in

Australia at the time of this investigation, the QS World University Rankings, 2016-2017 for Australia's top universities for Education were accessed (topuniversities.com), and the disability-inclusion content of pre-service and in-service education courses reviewed. The following four universities were listed in the world's top 20 at that time – the University of Melbourne, Monash University (Victoria), the University of Sydney (New South Wales), and the University of Queensland. In the following discussion, full course content was sourced for the University of Melbourne via the candidate's course completion, and course outlines and websites were accessed for the other three institutions.

The University of Melbourne (state of Victoria). The University of Melbourne offered two-year (full-time) graduate (Masters) pre-service teacher training courses in both primary and secondary education (education.unimelb.edu.au). These included a mandatory semester-long unit – *Diverse and Inclusive Classrooms*, which covered physical factors affecting learning and general ways to personalise instruction to learning need. In addition, primary (elementary) school teacher candidates completed a *Health and Physical Education* unit, supporting them as classroom practitioners to provide physical education – one of the more difficult aspects for generalist teachers (Quay & Peters, 2008). While the learning outcomes for this subject did not mention disability, input included customising activities to diverse learning needs, within which physical disability could be discussed (Quay & Peters, 2012).

The University also offered a one-year Master of Learning Intervention as an additional, elective, special education qualification for in-service (i.e., qualified and registered) teachers (<https://study.unimelb.edu.au/find/courses/graduate/master-of-learning-intervention>). Content of this course included universal design for learning (UDL) and inclusive assessment methodology. Throughout these courses, the focus was on facilitating access to the curriculum. Not being a curriculum area, classroom-based motor learning was not addressed, but strategies to adjust activities and environments to reduce their motor demand were noted.

Monash University (state of Victoria). Monash University offered both undergraduate and graduate primary and secondary pre-service teaching degrees (monash.edu/education). In each course, the semester-long subject *Learners with Special Needs* was mandatory, containing input on the impact of disability on classroom learning and development, and teaching practices that support inclusion. Primary teachers also completed the unit *Health and Physical Education for Wellbeing*, which included designing developmentally appropriate physical activities in that subject.

The University of Sydney (state of New South Wales). The University of Sydney offered both undergraduate and graduate primary and secondary pre-service education courses (sydney.edu.au/education_social_work). Mandatory units included the semester-long subject *Special and Inclusive Education*, which covered evidence-based inclusive education practices, and included a special school placement. In addition to this unit, all primary teacher candidates completed a *Personal Development, Health and Physical Education* subject, which included use of the subject to instruct in other key learning areas. Disability was not mentioned in the learning outcomes of this subject, potentially resulting in physical activities being planned without consideration of their accessibility, introducing additional learning barriers to students with physical disability.

The University also offered the one-year Master of Education (Special and Inclusive Education) to teachers looking for a formal special education qualification. While physical disability was included in the list of conditions covered, the focus, again, was on ensuring access to the curriculum. Elective units reflected this focus and included UDL principles facilitating access to key learning areas, and strategies for teaching these areas in the context of challenging behaviour, communication difficulty, and intellectual disability.

University of Queensland (state of Queensland). Queensland University offered both undergraduate and graduate primary and secondary pre-service teaching degrees

(education.uq.edu.au). Each required completion of the semester-long subject, *Diversity and Inclusive Education*. This introduced different disabilities, their impact on classroom learning, and ways to support students through individualised instruction. Primary teachers also completed the semester-long unit *Teaching Health and Physical Education*, which introduced this learning domain, and ways to facilitate physical activity, including more accessible, low-intensity kinds.

Summary of disability input provisions in Australian pre-service and in-service teacher training. At the beginning of 2016, the Commonwealth of Australia Senate paper on the learning access of students with disability noted that only the state of New South Wales required pre-service teacher training courses to include a unit on teaching students with disability, and recommended that this be rectified by other states (Commonwealth of Australia, 2016). In response, the overview of pre-service and in-service teacher education courses of Australia's top four universities provided by this research investigation has indicated improvements to that statistic, in the provisions of mandatory, semester-long introductory subjects relating to teaching students with diverse learning needs. In fact, analysis of the unit content of teacher education courses across Australia at the time of this research revealed this requirement was being met by universities in all states. In addition, the mandatory completion by primary (elementary) teacher candidates of a Health and Physical Education subject was providing them with additional input of potential usefulness to the support of students with motor learning needs.

However, while the learning outcomes of these courses mentioned the impact of physical disability on learning, curriculum-based instruction remained the professional responsibility and focus of teachers (Commonwealth of Australia, 2006). Classroom-related motor skill, not being a curriculum area, did not receive this consideration, nor were the movement requirements of classroom learning operationalised as occasions for the development of

motor skill (Evans, 2015). Instead, and in keeping with the social model, these aspects were more likely viewed as discriminatory barriers to remove (Oliver, 1989). In Australia, such commitment has resulted in significant improvements to the physical accessibility of schools, such that in 2015, the Australian Education Union could state that Australian schools were “adept at adjusting for physical disability” (AEU, 2015, p.5). However, at the classroom level, this adjustment often involved recruiting others to complete the physical aspects of tasks in a timely manner, rather than adjusting the tasks themselves. As mentioned earlier, this can result in over-dependence on adult assistance and loss of “mastery motivation” (Morgan, Harmon, & Maslin-Cole, 1990, p.318; see also Blatchford, Bassett, Brown, Martin, Russell, & Webster, 2011; Effgen & Chan, 2010; Egilson & Traustadottir, 2009a; Giangreco & Broer, 2007; Majnemer et al., 2010; Missiuna & Pollock, 1991; Ott & Effgen, 2000). This finding has been corroborated in research with adolescents with physical disability, who have noted difficulties achieving independence arising from non-consideration of motor learning needs in the physical organisation of classroom tasks and activities (Asbornslett & Hemmingsson, 2008; Colangelo & Olson, 2013; Egilson & Traustadottir, 2009b).

In conclusion, while pre-service teacher training in Australia has included mandatory input on disability inclusion, this has emphasized equitable *academic* curriculum access in compliance with legislation. It has also aligned to social model perspectives that, where physical disability is concerned, classroom motor requirements are barriers to be removed, not motor learning opportunities. However, elimination of all classroom movement requirements, or the use of others to complete them, has been suggested as a contributor to loss of motivation and over-dependence in students with motor performance needs. In the context of research findings demonstrating intact motor learning capabilities in students with physical disability and the importance of regular and consistent practice, this study proposes it might be worthwhile considering classroom-based movement as an important aspect of an

inclusive curriculum, and teacher capacity to differentiate instruction for students with motor performance needs as a valid area for professional development. The research behind differentiation and inclusive curriculum follows.

Differentiated Instruction Improves Learning

Declarations, policies, and legislative statements influenced a shift in special education, from remedial instruction and separate, ‘special’ curricula and classroom settings (Brennan, 1985; Cologon, 2013; Halliday, 1989; Lloyd, Forness & Kavale, 1998; Lonton & Farooqui, 1991; Valle & Connor, 2010), to more group-oriented interventions and general classroom settings (Baker & Zigmond, 1995), and access to the standard curriculum (ACARA, 2013b; Agran et al., 2002; Agran, Cavin, Wehmeyer & Palmer, 2006; Browder, Wakeman, Flowers, Rickelman, & Pugalee, 2007; Hardman & Dawson, 2008; Hitchcock & Stahl, 2003; Whinnery et al., 2016). At the same time, in response to a growing ability spread in regular classrooms (Goss & Chisholm, 2016), a shift in thinking about best practice occurred, from whole class, uniform instruction, or “teaching to the middle” of an age-standardised class, to individualised teaching that responds to student variance (Foreman, 2015, p.23; Glaser, 1981; Griffin et al, 2010; Smith, 2009; Tomlinson, 2005). Bringing these two aspects together has resulted in requirements for differentiated instruction, and an inclusive (expanded and flexible) standard curriculum (Broderick, Mehta-Parekh & Reid, 2005; Foreman, 2015; Loreman, 2007).

Differentiation is about teaching flexibly in the modern, diverse classroom, matching instruction to individual need (Birnie, 2015; Smith, 2009; Sousa & Tomlinson, 2011; Tomlinson, 2014). It involves teachers making ongoing changes to their teaching practice, the learning environment, and the curriculum, to keep students within their zone of proximal development, or “growing edge” of learning (Bruner, 1986, p.77; Rogoff & Wertsch, 1984; Vygotsky, 1978; Wood et al., 1976). This is in keeping with the fundamental concept in

education “underlying all teaching and learning”, of development, or progress (Masters, 1998, p.3; 2013), informed by the Vygotskian proposal that “learning which is oriented toward developmental levels that have already been reached is ineffective”, rather, “the only ‘good learning’ is that which is in advance of development” (Vygotsky, 1978, p.89; see also Griffin, 2009; Griffin et al, 2010). According to this view, the focus is not on evaluating student performance relative to others, but on facilitating each student’s development along the domain’s learning progression (Krajcik, 2011; Masters, 2013; Popham, 2014; Shin, Stevens & Krajcik, 2010). This requires “deep representations” of domains, resulting in their unfolding as progressive scales (Hattie, 2003, p.5), and the ability to assess capacity within these progressions, regarded as “high-order” skills that many teachers do not possess (Victorian DET, 2016, p.78), and to which, in fact, health professionals have not been significantly exposed (Baddeley, 1993; Dijkers, Hart, Tsaousides, Whyte, & Zanca, 2014a; Ehlhardt, Sohlberg, Kennedy, Coelho, Ylvisaker, Turkstra, & Yorkston, 2008; Fuhrer & Keith, 1998; Hart, 2011). These are the same skills required to successfully differentiate or personalise learning, allowing identification of both current understanding and what is ready next to learn (Timperley & Alton-Lee, 2008). Hattie (2008) has noted the “self-energising effect” of goals that are appropriately challenging (p.164), citing Fuchs and Fuchs’ (1986) research on the use of formative assessment with special education students to establish this challenge level, and Swanson’s (2000) research into scaffolding for the support of learners with intellectual disability. Bandura’s (1977) research into contributors to self-efficacy and capacity development has also established the contribution to high performance of goals pitched at the right level of challenge (see also Schunk, 1985). In relation to this study, differentiation would consider appropriately challenging motor learning opportunities for students with classroom-related motor learning needs. This would require not only teacher knowledge of this domain, but how learning progresses in it, and the use of diagnostic, or

formative assessment to identify the “zone of intervention” (Griffin, 2007, p.96; see also Bass & Glaser, 2004; Bloom et al., 1971; Heritage, 2010a; Maloney et al., 2014; Shepard, 2000, 2007; Tomlinson, 2014).

Formative assessment is assessment conducted while instruction proceeds, to monitor current learning and progress it (Shepard, 2007). “Actionable instructional decisions” require criterion-referenced interpretation of formative assessment results (Popham, 2014, p.64; see also Glaser, 1963). Traditional, norm-referenced interpretation equates individual achievement with the norm group but does not align student performance to the learning domain, which is what instructional decision-making requires (Bass & Glaser, 2004; Black & Wiliam, 1998a; Shepard, 2000; Wiliam & Black, 1996). However, while formative assessment and criterion-referenced interpretations support student learning (Black & Wiliam, 1998b; Shepard, 2009), teacher ability to locate the area of next learning focus has remained challenging. (Heritage, 2008; Heritage, Kim, Vendlinksy & Herman, 2009). What is needed is an underpinning understanding of how learning progresses in a domain area (Masters, 1998). This is the rationale for the use of learning progressions in education. In addition, better resourcing is required, through curriculum coverage that includes important foundational learning areas, and provides for their sequenced instruction (McTighe & Brown, 2005; O’Meara, 2011). The nature of such inclusive curriculum will be discussed next.

An Inclusively Framed Standard Curriculum Supports Differentiation

The requirement to ensure a properly adapted, inclusive curriculum is the second major theme supporting the classroom learning of students with disability (Foreman, 2015; Mara & Mara, 2012; Shaddock, 2007; Shaddock, MacDonald, Hook, Giorcelli, & Arthur-Kelly, 2009). It assumes that one curriculum is sufficient for all learners, provided it can be modified to include expanded and flexible content and expectations, enabling tailoring to both learning area need and learning stage (ACARA, 2013b; Clayton, Burdge, Denham,

Kleinert, & Kearns, 2006; Konza, 2008; Jackson, Ryndak & Billingsley, 2000; Jenkinson, 2001; VCAA, 2015; Westwood, 2003). Research has confirmed the importance of different kinds of modifications to enabling general curriculum access – specifically, curriculum augmentation and adaptation (Knowlton, 1998; Wehmeyer, Lance, & Bashinski, 2002; Wehmeyer et al., 2001; Wehmeyer, Lattin, Lapp-Rincker, & Agran, 2004; Wehmeyer, Sands, Knowlton, & Kozleski, 2002). Curriculum augmentation does not adapt or alter the curriculum but enhances or fortifies it with “overlying content” – education in important curriculum-related capacities and skills (Knowlton, 1998, p.100). This is similar to embedded instruction, which has been successful in teaching targeted skills within existing school routines (Whinnery et al., 2016). Curriculum adaptation, on the other hand, adjusts the curriculum to accommodate for impairment, through provision of many teaching and learning alternatives that work around absent skills. The former is focused on skill development in impairment-related areas, while the latter seeks to improve access and participation, and undergirds the UDL approach (Hitchcock, Meyer, Rose & Jackson, 2002). A third option, curriculum alteration, expresses the special education ‘alternative curriculum’ approach (Knowlton, 1998).

A high-quality curriculum has been recognised as essential for achieving quality learning outcomes (Marzano, 2003). It consists of knowledge, skills and concepts sequenced progressively, rather than collections of disconnected items (Heritage, 2008; McTighe & Brown, 2005; O’Meara, 2011). Foreman (2015) noted a recent Australian lead in this regard in a national curriculum project providing sequenced learning continua for each subject area, and an online format permitting teachers to filter and select content and support materials at any point along those learning trajectories (ACARA, 2013a, 2013b). Additional input from the Victorian version of the Australian curriculum included fewer and more comprehensive

level statements that were more descriptive of the broader range of abilities in modern, year-level classrooms (Howes, 2012; VCAA, 2015).

In considering an inclusive curriculum approach to motor learning for students with physical disability, Table 3 notes the frequent reference to motor skills in the Australian Curriculum's General Capabilities at Foundation level (first year of formal education), as well as their lack of progressive, or curricular, development (ACARA, 2010 to present).

Table 3 *Australian Curriculum, Foundation Level A: Sample Movement Indicators*

Literacy	Numeracy
Comprehend texts	Use numbers
- Follow a visual schedule to <i>complete a task</i>	- <i>Demonstrate</i> counting
	- <i>Model</i> addition and subtraction
Compose texts	Spatial reasoning
- Create texts with familiar structures such as <i>print</i> texts, <i>illustrations</i> , etc.	- <i>Sort or match</i> objects
- <i>Replicate rhythms</i> and sounds	- <i>Follow directions</i>
- Use visual elements, such as <i>drawing and writing</i>	- <i>Sort</i> familiar 2- and 3-dimensional shapes
- Retell familiar literary texts through <i>performance</i>	- <i>Copy, continue and create</i> patterns with <i>objects and drawings</i>
- <i>Construct</i> texts using software	- <i>Sequence</i> familiar <i>actions</i>
- <i>Correctly form all letters</i>	- <i>Fold or cut</i> a shape
	Statistics
	- <i>Display data using real objects</i>
	Measurement
	- <i>Use informal actions</i> to describe length,
	- <i>Pour</i> liquid into container
	- <i>Sort and classify</i> familiar <i>objects</i>

Were these important motor skills to include those preceding the first year of school entry, progressively developed, there would be greater possibility of identifying a student's current learning stage and setting realistic progress goals. This would constitute a work of curriculum augmentation akin to the Australian Curriculum's General Capabilities of

Personal and Social Capability, Literacy, and Numeracy (ACARA, 2014), the *Students with Additional Needs* collaborative project of the Victorian DET and the University of Melbourne (Australian Government DET, 2015b), and the performance attainment targets (P scales) of the UK curriculum (Government of the United Kingdom, 2017) to be discussed next.

Pre-Foundation learning indicators in the Australian Curriculum. In response to review recommendations to provide further assistance to teachers in personalising learning for students with learning needs (Department of Education, 2014), ACARA developed pre-Foundation (F) learning indicators for three of its General Capabilities – four additional levels for Literacy, and one additional level each for Numeracy and Personal and Social Capability (ACARA, 2014). In this regard, the Australian Curriculum approached a requirement of an inclusive curriculum, being a single, customisable learning progression that recognised different levels of instructional need and provided tailored curriculum resourcing on the assumption that all students could learn with appropriate support (Masters, 2013). Table 4 provides an example of this extension to the learning continua for Literacy and Numeracy (skill increase shown in *ascending* order):

Table 4 *Australian Curriculum Pre-Foundation Sample Extension Indicators*

Level	Literacy: Comprehend texts	Level	Numeracy: Calculate whole numbers
1e (F)	Navigates, reads and views simple texts with familiar vocab and supportive illustrations	1b (F)	Connect and order numerals and groups of objects using numbers up to two digits
1d	Uses conventional behaviours and/or abstract symbols consistently for different contexts & people	1a	Demonstrate concepts of counting using every day experiences (e.g., showing anticipation that something will happen on the count of 1, 2, 3)
1c	Uses conventional behaviours and/or concrete symbols consistently (e.g., responding to requests)		
1b	Uses informal behaviours that show consistent anticipation of familiar events		
1a	Uses behaviours not intentionally directed at others to attend, respond, or show interest		

Across these two progressions, physical behaviours have been used to indicate pre-Foundation levels of literacy or numeracy. This supports research findings that motor capacity is important for early learning (Kall, Nilsson & Linden, 2014; Vuijk, Hartman, & Mombarg, 2011; Werner & Raab, 2013). However, these different movement descriptions do not constitute an embedded curricular progression in motor skill acquisition. To achieve this, the motor skill component would need fuller expression, including descriptions of its nature, scope, and evidence base, and its main aspects or “organising elements” (ACARA, 2014). Progression points would also need fuller description, to express the nature of learning in the domain. In these ACARA indicators, what is provided is too general to support differentiated instruction. In addition, there is inconsistency between the progressions, as in literacy, anticipatory movement skill (1b) is followed by two further skill levels before Foundation (1e), whereas the same skill in numeracy (1a) proceeds directly to Foundation (1b).

Extended learning progressions in the Victorian Curriculum. At the time of this investigation, the Victorian DET was completing a research-based version of ACARA’s work, through a joint project with the University of Melbourne (Australian Government DET, 2015b). This had produced validated, extended learning progressions in English (Woods & Griffin, 2008) and Personal and Social Learning (Coles-Janess & Griffin, 2009; Roberts & Griffin, 2009), utilising a developmental assessment frameworks approach to instrument design (Griffin, 2007, 2009). No curriculum development of pre-Foundation classroom-based motor skills was envisioned for this project, or any Australian curricula. Nor did ACARA’s Australian Curriculum for Health and Physical Education (HPE) provide indicators below Foundation, and while the Victorian HPE curriculum provided four-levels of pre-Foundation indicators for its Movement and Physical Activity strand (Moving the Body component), these did not relate to the motor requirements of the classroom. Motor learning literature has confirmed that skill-development is specific to context, with the natural context

for use of a skill playing a key role in its acquisition and consequent transfer (Hollenbeck & Miller, 2013; Phipps & Roberts, 2017; Shumway-Cook & Woollacott, 2012). The Victorian HPE indicators also lacked the specificity needed to operationalise domain aims (Popham, 2014). As seen in the following general descriptors, this reduced their usefulness to teachers looking to clarify and operationalise learning targets:

- Level A – experiencing being moved and being included in simple physical activities,
- Level B – practicing gross motor movement; exploring space; trial and error learning,
- Level C – moving the whole body; moving over a range of objects and surfaces;
participating in games with rules,
- Level D – increasing fine motor control in different environments; problem-solving to
negotiate space; manipulating objects in more challenging situations.

The P scales of the UK Curriculum. A more detailed pre-Foundation curriculum expansion, which referred to movement in other learning areas, was found in the UK Department for Education's (2017) performance attainment targets, or P scales (Government of the United Kingdom, 2017). Eight stages were identified in this document, with the first three describing students working at earliest emergence of intentionality, after which the descriptors became more subject-specific. Movement-related examples at each skill level were provided. However, throughout, normative patterns are described, rather than strategies that would permit movement equivalence (Gentile, 1987). For example, the Physical Education scale stated that by Level 5, students would successfully link two mobility actions, such as climbing and jumping; and by Level 7 they would travel over and under climbing equipment and throw balls to partners. These are descriptions of typical motor development, rather than suggestions for scaffolding students with motor performance needs. Table 5 provides a movement-selected sample of the first three levels (again, skill increase is shown in *ascending* order).

Table 5 *Sample Movement-related Indicators of the UK P Scales (Levels 1 to 3)*

Level	English	Mathematics	Art	Physical Education
P3 level	Communicates intentionally, observes results of actions, initiates, anticipates known events, makes choices, actively explores			
<i>P3 examples</i>	Seeking attention through gesture, pointing to objects or people, pre-empting actions in familiar poems, nodding and shaking head, turning pages in a book	Pointing to one object rather than another; manipulating objects into piles, dropping objects to prompt intervention from others	Making banging, stroking and circling movements with a paint-brush, dipping a spreader in glue, banging clay with a tool to flatten it	Bouncing on a trampoline, moving when the music starts, moving around a space encountering obstacles, reaching out a foot or hand to intercept a moving ball
P2 level	Response consistency, shows interest, participates with support, remembers learned responses			
<i>P2 examples</i>	Gesturing in a particular way in response to a favourite visitor; showing pleasure each time a particular puppet character appears in a poem dramatised with sensory cues; taking turns in interactions with a familiar person, imitating actions and facial expressions	Becoming excited or alarmed when a routine is broken; tracking objects briefly across their field of awareness; lifting objects briefly towards the face in shared investigations; repeating an action with a familiar item of equipment;	Grasping a painting sponge; returning their hands to a particular texture; working with an adult to press, roll, or pinch wet clay	Patting at footballs brought towards them; smiling in dance or movement activities; creating patterns of movement with guidance or support
P1 level	Reacts, shows alertness, emerging awareness			
<i>P1 examples</i>	Attending briefly to interactions with a familiar person; sometimes becoming excited during social activity	Startling at sudden noises or movements; grasping objects briefly when they are placed in their hand; showing surprise at the sudden presence or absence of an event or object	Looking briefly at brightly coloured objects; sometimes putting their hands in wet paint	Turning briefly towards fast-moving group activities; sometimes turning away from people or objects moving close to them

Finally, the P scales assume that motor development tracks along with academic learning, which is evident in indicators describing increasingly sophisticated fine-motor skills to denote higher performance in the academic domain, for example:

- briefly grasping materials placed in the hand is at P1,
- patting, pressing and grasping with help or coaxial support is at P2,
- pointing, turning pages and manipulating objects into piles is at P3,
- assembling and building with objects is at P4,
- managing different dynamics and tempos when playing rhythm instruments is at P5, and
- using complex tools and equipment in multi-step tasks is at P6 and beyond.

Whether increasingly refined, normative fine-motor skills are used to indicate advanced academic learning, as in the P scales, or movement is generally alluded to without progressive development, as in the Australian Curriculum, movement is not the primary instructional focus of these curriculum documents; in fact, a reduced place for movement and motor skills overall in educational curriculum overall has been noted (Hay, 2006; Nyberg & Larsson, 2014). Hence, it is unsurprising that curriculum resourcing to support generalist classroom teachers to develop motor skills is minimal (Egilson, 2011; Gee, 2002; Gee et al., 1995), and that the focus in UDL is on identifying alternative ways to complete tasks or demonstrate understanding, for example, scaling back writing requirements, working in teams that involve others completing motor aspects, or providing technology alternatives to movement tasks (Gal, Schreur, Engel-Yeger, 2010; Gargiulo & Metcalf, 2017; Heller, Forney, Alberto, Sherwood, & Schwartzman, 2009; Hitchcock et al., 2002; Majnemer et al., 2010). The interest of this research is to consider a curriculum augmentation goal that might support the progressive acquisition of classroom-related motor skill. In other words, rather than asking, ‘How can this student sort these items into piles without using movement?’,

considering ‘How can this task be structured so this student can use their emerging motor skills to sort these items, in such a way that their movement capability also develops?’ This assumes intact motor learning capability in terms of achieving optimal use of one’s own movement, and abilities in strategic use of enablers and constraints in tasks and learning environments to achieve goals (Carr & Shepherd, 2006; Charles & Gordon, 2007; Gentile, 1992; Nyberg & Larsson, 2014; Ryle, 1945; Whitehead, 2010). In summary, in relation to this research, practices of differentiation and inclusive curriculum should ensure:

- curriculum is augmented (Knowlton, 1998; Wehmeyer, Lance et al., 2002) by embedding classroom-related motor skills instruction as an important cross-curricular learning area,
- teachers know how motor skills progressively develop, with sufficient detail at the early learning stages to encompass the abilities of students with motor learning needs (Tomlinson, 2014), and
- teachers can establish both where students are in their motor learning journey, and what is ready next to be learnt, through formative assessments grounded in the domain’s learning progression (Bruner, 1986; Heritage, 2010b; Vygotsky, 1978).

These practices that enable students to be identified within the progressive stages of the learning domain describe quality education and should be applied to classroom-related movement capability as an important serving competency that needs intentional development for some. This requires collaboration with school-based rehabilitation professionals trained to assess and support functional motor development – one important professional group being occupational therapists (Boshoff & Stewart, 2013; Hinder & Ashburner, 2010; Clark et al., 2007; McDonald et al., 2001; OTA, 2012). This leads to a fourth and final aspect of the review of research in this area.

Occupational Therapy Supports Motor Skill Learning in Classroom Settings

Occupational therapy is a client-centred health profession, concerned to “promote health and wellbeing through occupation” (World Federation of Occupational Therapy [wfot.org], 2013; AOTA, 2014; Canadian Association of Occupational Therapists [CAOT], 1991; OTA, 2012, 2016). Occupation is defined broadly by the profession to include all the things people need to do, want to do, and are expected to do in their lives, with occupational therapy intervention using occupation as both means and goal (Kaplan, 2010; Kielhofner, 2008; Molineux, 2004; Rodger & Kennedy-Behr, 2017). In relation to children, paediatric occupational therapists have specific knowledge and skills pertaining to child development, childhood occupations, disability, assessment and outcome measurement, goal-setting, and evidence-based interventions, which they apply to improve occupational performance, including motor performance for school-based learning (AOTA, 2011; Bayona, McDougall, Tucker, Nichols, & Mandich, 2006; Case-Smith, 2015; Colangelo & Olson, 2013; OTA, 2015a; Mancini & Coster, 2004; Silverman & Bourke-Taylor, 2009; Swinth & Hanft, 2002). These interventions include developing perceptual, motor, and sensory capacities and skills to improve posture and mobility (Hollenbeck & Miller, 2013; Wright-Ott, 2015), tool use and handwriting (Case-Smith, 2013; Case-Smith & Exner, 2015; Frolek Clark & Giroux, 2013; Jackman & Stagnitti, 2007), independence in activities of daily living (Shepherd, 2015), and more successful social participation and play (Maloney & Chandler, 2013; Tanta & Knox, 2015).

Methods of occupational therapy intervention for physical dysfunction have changed significantly across the 20th and into the 21st century (Carr & Shepherd, 2006). Prior to the 1950s, the focus of physical rehabilitation was on exercising individual muscles, then, following an influx of young adults with acute brain injury after the second world war, new thinking about the role of the nervous system in movement emerged, and methods to

facilitate neurophysiological return. Particularly, the approaches of Neurodevelopmental Therapy (Bobath, 1990) and Proprioceptive Neuromuscular Facilitation (Knott & Kabat, 1954) dominated physical therapy across the remainder of the 20th century. Towards the end of that period, from the 1980s, new research into muscle adaptability, the psychology of motor learning, and the context-dependent nature of movement supported a move from passive, non-muscular styles of intervention to active roles for the client in therapy, and then, from the 21st century, technological developments and reconceptualization of nervous system functioning influenced a shift to systems thinking and a greater focus on whole motor performance for actual task achievement rather than concern to improve movement sub-components (Levac & DeMatteo, 2009; Shumway-Cook & Woollacott, 2012; Zwicker & Harris, 2009). One implication of these significant shifts in thinking is the possibility that current practicing therapists trained at different times may be operating with varying perspectives.

In Australia, at the time of this investigation, most therapists provided services to schools as private practitioners, and their intervention was predominantly indirect, via collaboration and consultative advice to classroom teachers and education support staff (OTA, 2012, 2015a). Such collaborative consultation was also regarded as best practice internationally (Dancza et al., 2017; Hinder & Ashburner, 2010; OTA, 2016, 2017; Polatajko, Mandich & Martini, 2000; Polatajko & Mandich, 2004; Rainforth, 1992; Wintle, Krupa, Cramm, & DeLuca, 2017). Assessment began the process of engagement (Bundy, 1995; Hinojosa, Kramer, & Crist, 2014), and, to support the indirect, consultative approach, in addition to standardised and criterion-referenced occupational therapy administered assessments, judgement-based questionnaires were developed for teachers to complete from their existing student knowledge. Review of these assessments will take place in Chapter Four – here briefly, their main purpose was to screen for impairment-related difficulties and inform

therapists about general issues and possible need for further, formal testing. Amongst some mixed reviews by therapists about teacher ability to make accurate judgements about motor ability using these assessments (Green, Bishop, Wilson, Crawford, Hooper, Kaplan, & Baird, 2005; Junaid, Harris, Fulmer, & Carswell, 2000; Revie & Larkin, 1993; Schoemaker, Smits-Engelsman, & Jongmans, 2003; Wright & Sugden, 1996), their capacity to do so, based on their extensive student knowledge in a wide range of natural situations, has been affirmed, provided the assessment items referenced classroom-relevant and observable skills directly, and had clear and understandable rating scales, or metrics for reporting judgements (Clauser, 2000; Cumming, Wyatt-Smith, & Elkins, 2006; Davies, Soon, Young, & Causen-Yamaki, 2004; Faught, Cairney, Hay, Veldhuizen, Missiuna, & Spironello, 2008; Kim, Murrah, Cameron, Brock, Cottone, & Grissmer, 2014; Netelenbos, 2005; Rubie-Davies, Hattie, Townsend, & Hamilton, 2007; Schoemaker, Flapper, Reinders-Messelink, & de Kloet, 2008; Winne & Perry, 2000). This raises a question about purposes and audiences for assessments and suggests a need for therapists to understand teachers' curricular responsibilities (Bonnard & Anaby, 2016; Law, Lindsay, Peacey, Gasgoigne, Soloff, Radford, & Band, 2002; Lindsay, 2003; McDonald et al., 2001; Swinth & Hanft, 2002; Villeneuve & Shulha, 2012) and to provide "educationally relevant services" (Fisher et al., 2007, p.2; see also Boshoff & Stewart, 2013). In fact, while both education and rehabilitation have noted the need for teachers to be equipped to work with students with disabilities and motor performance needs (Department of Education and Training Victoria, 2016; Forlin et al, 2013; Nye & Sood, 2018; OTA, 2012, 2015a, 2017; Shaddock, 2007), this investigation argues that occupational therapy assessment results also need to support learning stage identification.

Chapter Summary

This chapter has outlined three main drivers for improving educational access that relate to students with physical disability and which support a curricular focus on classroom-related

motor learning. These are 1) international statements, policies and rights-based models of disability, 2) legislative rulings and expectations, and 3) findings from prior research.

In relation to international and national Australian policies and legislation, and rights-based movements and models of disability, these have affirmed the right of access of all children to an inclusive, general curriculum that develops important capabilities, including the capability to achieve one's movement goals, and maximises individual potential. Findings from research and innovative practice have confirmed the reality of intact motor learning abilities in students with physical disability, the importance of movement to maximisation of functioning and capabilities realisation, and the contribution of construct learning progressions to successful differentiated instruction. In relation to physical disability, this has suggested an important goal of developing classroom-related motor skill progressively as a foundational learning area – requiring a deep representational knowledge of the domain, contextualised for the classroom, and an understanding of how learning in it develops progressively (Hattie, 2003). Occupational therapy input is recommended, as a profession with expertise in goal-directed movement development, albeit requiring expansion of assessment purpose to include a formative goal of identifying learning stage. Exploring movement and its growth follows in Chapter Three, then Chapter Four will consider assessment design methodology and a model that begins with establishing an underpinning learning progression.

Chapter Three: A Conceptual Framework for Defining the Movement Construct

Our nature lies in movement.

(Blaise Pascal)

This chapter reviews a body of research on goal-directed movement, to gain a “deep representation” understanding (Hattie, 2003; p.5) and to hypothesize a classroom-related motor skill sequence and learning progression for later empirical testing. Masters (2013) has expressed such representation as the horizontal and vertical structure of a learning domain, with the vertical component describing student progress or developmental learning and the horizontal component depicting its main aspects and a non-exhaustive set of indicative skills (see also AERA, APA, & NCME, 1999; Glaser, 1981; Griffin, 2009, 2018; Pellegrino, Baxter, & Glaser, 1999; Wolfe & Smith, 2007; Young & Tong, 2015). Figure 4 depicts the basic structure.

Domain description: accessible to target group	Vertical aspect: positive indicators of increasing proficiency		High ...	...	...	...	...	...	...
			Mid ...	...	...	...	...	...	...
			Low ...	...	...	...	...	...	...
	Horizontal aspect: categories and skills		Skill 1a	Skill 1b	Skill 2a	Skill 2b	Skill 3a	Skill 3b	
			Category 1		Category 2		Category 3, etc.		

Figure 4. Horizontal and vertical structure of learning domains

“Vertical scaling” has been described as providing an additional layer of progressive learning descriptors to assessment items – “content within content”, with these layered elements expressed as a vertical function (Gierl & Lai, 2015, p.424). The concept is central to good assessment design and to Glaser’s (1963, 1981, 1994a, 1994b) concept of criterion-referencing, with its concern to measure qualitative progress along a developmental pathway rather than to exhaustively itemise every domain skill (Griffin, 2009). In relation to the development of goal-directed movement in children with motor performance needs, positively defined markers of learning progress are required, as identifying what can be learnt

is not possible when lower levels are described as deficits of higher levels or negatively compared to typical benchmarks not possible to attain (Griffin, 2018).

This chapter contains three sections. Firstly, an introductory section summarises Bernstein's (1984, 1996) and Gentile's (1987, 1992) influential conceptions and categorisations of movement and motor skill acquisition, with a goal of achieving a disability-accessible description of what is entailed in competent movement. Secondly, a review of motor control, development and learning literature considers the different conceptions of how motor skill advances (that is, Masters' [2013] 'vertical' aspect), and thirdly, physical rehabilitation literature is reviewed for ways the domain has been categorised to support intervention, and the identification of classroom-important motor skills (that is, Masters' 'horizontal' aspects).

A Description Accessible to Describing Ability in the Context of Impairment

Movement has been described as our most fundamental psychological activity, undergirding everything we do (Adolph, 2013; Jeannerod, 1997; Rosenbaum, 2010). While much is spontaneous and involuntary, it is the intentional, *goal-directed* remainder (Gentile, 1972; Reed, Montgomery, Palmer, & Pittenger, 1995; Tresilian, 2012) – the control and coordination of the body to achieve task-relevant solutions – that concerns this research. This aspect of the development, learning, and control of functional movement has incorporated findings from diverse sources of motor learning and control, cognitive and developmental psychology, human ecology, biomechanics, and physiology (Adams, 1987; Campbell, 2012; Effgen, McGee & Scalzo, 2013; Kaplan, 2010; Newell & Rovegno, 1990; Nyberg, 2014).

Adaptive movement behaviour, with its extensive connection to human activity, has proven “notoriously difficult to describe” (Reed, 1992, p.129). Narrow, broad, and many intermediate level descriptions exist, “from movement at a single joint, to integration into (life situations)” (Polatajko et al., 2004, p.261; Reed, Montgomery, Schwartz, Palmer, &

Pittenger, 1992). For the purposes of describing learnable movement accessibly for individuals with motor performance difficulties, a categorisation helpful to this research is that of Gentile (1987), who proposed three increasingly detailed, or molecular, levels of description – actions, movements, and neuromotor processes:

1. *Actions* analyse movement at its most molar level, with a focus on the result brought about; the observable change in state between initial and final conditions – ‘packing up’ being a classroom example. This relates to the *participation* classification in the ICF (WHO, 2007), describing engagement from a societal perspective, with participation defined as “involvement in a life situation” (p.229). At this level, actions can be evaluated without observing the movements that produce them (Gentile). Additionally, where participation is the goal, environmental adaptation to ensure participation is as legitimate an action as movement (Hollenbeck & Miller, 2013). For these reasons, this *general outcome* description of movement is too general for this study, whose focus is observable motor skills.
2. *Movements*, the second level, are observable, and can be further sub-divided into *strategies* or *patterns* (Gentile). This relates to the *activity* classification of the ICF (WHO), describing engagement from the individual’s perspective, and activity as “the execution of a task or action by an individual” (p.229):
 - a. *Strategies* describe movements more generally in relation to goals, for example, ‘moving from desk to cupboard’, or ‘avoiding obstacles’. Keogh and Sugden (1985) have defined *actions* similarly, as “concerned with the movement’s intent and function and its interplay with the environment.” (p.7); similarly, von Hofsten (2004) has referred to “actions and not (movement) reactions ... initiated by a motivated subject, defined by a goal, and guided by information” (p.266). The concept of functional mobility – “moving from one

position or place to another, performing functional ambulation, and transporting objects” provides a similar, general level definition (Wright-Ott, 2015, p.560),

- b. *Patterns* specified the way strategies are achieved – crawling, for example (Campbell, Palisano, & Orlin, 2012). These can refer to whole actions, further differentiated to type – discrete tasks, such as kicking a ball, which have recognisable beginnings and endings, and continuous tasks, such as walking, which describe ongoing actions (Zwicker & Harris, 2009). Alternatively, these descriptions can relate to components of motor performance, as in the AOTA Framework (2014), where motor skills include such sub-aspects as positioning, stabilising and aligning (see also Fisher & Jones, 2011, 2014). Hand skills are generally defined to this more specific level, as “patterns of hand function, (involving) reach, grasp, carry, voluntary release... in-hand manipulation, and bimanual skills” (Case-Smith & Exner, 2015, p.220).

While qualitative descriptions can be provided for both strategies and patterns, strategy descriptions allow for movement equivalence – multiple ways an outcome can be achieved and, therefore, are more useful than patterns to describing skill positively in the context of physical disability (Gentile, 1987). Strategy description enables movement to be judged against goal criteria, rather than against standard ideal patterns or forms.

3. *Neuromotor processes* provide movement’s most molecular description and refer to the non-observable mechanisms underlying motor activity. This is to discuss movement at the ICF level of body functions – “physiological functions of body systems”, and structures – “anatomical parts of the body” (WHO, 2007, p.9). As these are non-observable, this level is also not the focus of this study.

Bringing this material to the requirements of its measurement, a third element is added to Thorndike's (1982) classification of performance measurement as product or process:

1. Product evaluation focuses on the tangible product as an *artefact*, separate from the movement that produced it, which aligns to Gentile's (1987) *action* level; for example, evaluating the neatness and legibility of a written piece of work regardless of whether this is produced by personal neat handwriting, the use of a scribe, or automatic transcription from dictation software.
2. Process evaluation, on the other hand, assesses the movement as it occurs against a normative standard for that movement regardless of outcome, aligning to Gentile's *patterns* level – an example being the quality of grip strength or walking form.
3. Gentile's *strategy* level combines both product and process considerations, as it evaluates movement against an interim outcome as a *product*, but one requiring movement to be the means of achievement, while also evaluating how well that movement as a *strategic process* works to achieve the goal, without stipulating its outward form; for example, evaluating the *movement strategy* used to avoid an obstacle, not the quality of the postural control (process/patterns level) or the extent to which the obstacle was successfully avoided (product/actions level).

Having identified the *strategy-level categorisation* of movement as accessible to people with motor performance difficulties, a *description* of this domain follows, drawing on Bernstein's (1984, 1996) seminal insights into dexterity and how it is acquired. Bernstein's work integrates the three main fields of endeavour: motor control, motor development, and motor learning (Kaplan, 2010):

- Motor control focuses on the neuromotor processes underlying the planning and execution of movement (Beek & Meijer, 1988; Latash, Levin, Scholz, & Schöner, 2010; Newell, 1991; O'Brien, 2015; Phipps & Roberts, 2017),

- Motor development studies physical maturation and development of coordinated movement from infancy, and has demonstrated the role of practice in the attainment of controlled movement from the outset (Adolph & Robinson, 2015; Beek & Meijer, 1988; Mounoud, 1986), and
- Motor learning concerns “processes associated with practice or experience leading to relatively permanent changes in the capability for movement” (Zwicker & Harris, 2009, p.30; see also Schmidt & Lee, 2011).

While these separate foci have supported research attention and advances in understanding, there is considerable overlap between the categories, with each adding to an overall understanding of the construct (Newell, 1991; Shumway-Cook & Woollacott, 2012; Sugden, 2007; Ulrich, 2007). The usefulness of maintaining the connection can be seen in Bernstein’s classic and influential studies on dexterity (Bernstein, 1996) and motor coordination (Bernstein, 1984). These works retain an integrated focus and have been regarded as “beyond any competition” in the fields of motor and rehabilitation research (Latash & Latash, 1994, p.56) – “required reading for any student of human movement” (Thelen, 1998, p.267), where they have continued to be extensively referenced (Carr & Shepherd, 2006; Davids et al., 2003; Dewey & Wilson, 2001; Feigenberg, 2014; Gentile, 1987, 1998; Kaplan, 2010; Latash, 2007; McCoy & Dusing, 2012; Missiuna, Mandich, Polatajko, & Malloy-Miller, 2000; Newell, 2003; Newell, Broderick, Deutsch, & Slifkin, 2003; Tani, Corrêa, Basso, Benda, Ugrinowitsch, & Choshi, 2014; Thelen, 2005; Westcott McCoy & Dusing, 2012; Wulf & Prinz, 2001). Through an analysis of Bernstein’s insights, suggestions in relation to the goals of this chapter will be firstly made, after which pertinent contributions from these three fields will be analysed for further explication or critique.

Bernstein's Influential Concept of Learnable Dexterity

Bernstein, a Russian contemporary of Vygotsky, was influenced by Vygotsky's (1993) views of learning; in fact, Bernstein's "physiology of activity" paralleled Vygotsky's social-constructivist "psychology of activity" (Bongaardt & Meijr, 2000, p.65; Reed, 1982). Skilled movement, or dexterity – the ability to "tune (a) movement to an emergent task" (Bernstein, 1996, p.23), is insufficiently explained as a consequence of neuromaturational development; rather, the actions of the body for task-achievement influenced and advanced nervous system development, with a goal of optimal outcome, not perfection of form (Bernstein, 1984; Case-Smith, 2015; Thelen & Adolph, 1992). Resourcefulness is the "most essential feature" of advanced motor skill (Bernstein, p.67). This proposes movement as pre-eminently learnable with practice – it can be developed, which also means it can fail to be learnt or to receive sufficient practice. Most importantly for this study, what is learnt during movement is not normative movement patterns but "motor wits" – the intelligent use of the body for goal achievement – essentially a problem-solving or solution-finding strategy using the available resources of the body (Bernstein, 1996, p.20). Gentile's (1987) strategy categorisation utilised by this research drew upon Bernstein's insights.

The 'Degrees of Freedom' Problem

To Bernstein, the human body begins as an unstable and uncontrolled system, unable to move intentionally, with a "degrees of freedom", or redundancy problem related to its extensive muscle elasticity and joint range (1996, p.29; Latash, 2012a, 2012b). This results in an over-abundance of possible ways to achieve any movement goal – so many, in fact, that it should not be possible to achieve quick selection and effective action, and yet this capacity ultimately eventuates. Achieving this involves the senses – sight, hearing and proprioception, guiding and correcting movements as they take place in pursuit of goals, and extensive, varied practice in real-life situations, resulting in individual movements progressively

combining into larger patterns, or synergies, based on those goals, not on particular muscles and joints. Latash and Anson (1996) drew on this insight of redundancy to argue against goals of “normal” movements for people with impaired motor systems. Bernstein’s insights has thus directed focus of attention “from studying the *what* of movement (its internal trajectories) to studying the *how* (analysis of all underling mechanisms contributing to the movement outcome)” (Bongaardt & Meijer, 2000, p.60). In similar vein, Bernstein also considered movement *correctness* and *rationality* in relation to the end-goal and the needs of the performer (Bernstein, 1996). A movement is *correct* in relation to its result – the extent to which it meets the requirements of the task with appropriate quickness, economy and resourcefulness. A movement is *rational* in relation to itself, not in the sense that it conforms to a standard format, but that it achieves the result desired in a way most expedient and economical to the mover – again, a description accessible in the context of motor impairment.

Bernstein (1996) underlined the necessity of extensive practice of a certain kind to achieving competent movement. The repetition of the search for coordinated control in real time is the practice that produces correct, rational movement – repeating a clumsy movement in itself cannot improve it: “During a correctly organised exercise, a student is repeating many times, not the means for solving a given motor problem, but the process of its solution, the changing and improving of the means” (Bernstein, p.205; see also Magill & Anderson, 2014; Newell, 1991, Phipps & Roberts, 2017; Thelen, 1995). This is what Bernstein meant by “repetition without repetition” practice (Bernstein, p.204). Pre-eminently, dexterity – “the queen of motor control” (p.208) depends on opportunities to learn, which Bernstein perceived to be everywhere, as almost every real-life action requires some element of adaptability and quick-wittedness – “like gold specks, (they) are scattered all around the world of our everyday movements, just like those in the gold-bearing sand on the river bed” (p.213-214). Many authors have noted this extensive real-life practice requirement for achieving motor

skill, and the implications for individuals whose movement impairments reduce access to such opportunities (Adolph & Berger, 2006; Effgen & Chan, 2010; Gordon & Magill, 2012; Shumway-Cook & Woollacott, 2012).

Finally, in relation to what could be learnt, Bernstein (1996) understood four aspects to human physical capacity, increasing in complexity and availability to learning. The first aspect of strength is virtually a purely physical capacity, followed by speed and endurance, which involves learned coordination across various bodily subsystems, and finally, dexterity involves learned *resourcefulness* in relation to environmental and task demands, enabling the mover, ultimately, to “find a motor solution for any situation” (p.21).

Taxonomy 1: Bernstein’s conception of motor skill advance. Summarising his perspectives on the progressive attainment of motor skill in support of a vertical or developmental learning scale (see Masters, 2013; Young & Tong, 2015), Bernstein (1996) proposed that mastery occurs across three progressive stages (Davids, Button, & Bennett, 2008; Latash, 2012b; Newell, 1985):

1. Co-ordination – the first stage of learning involved freezing, or reducing, many biomechanical degrees-of-freedom at the periphery, thereby reducing the computational load of an otherwise unmanageable number of discrete elements. This allows a reduced set to organise into functional groupings, or synergies. At this stage, the movement is slower, more constrained, and involves greater concentration for its successful achievement. Variable performance within this restricted set lessens over this time, concluding at the end of this phase with an initial level of automaticity and proficiency of the basic form in known environments.
2. Control – the ban on degrees-of-freedom is then lifted, producing more flexible performance capable of managing environmental changes (Latash, 2012a).

Improvement is not gradual, however, but is marked by abrupt and qualitative changes and temporary setbacks, as new ways to enact and correct the movement take time to stabilise, and older practices to fade (Bernstein, 1996). This can also be achieved with compromised quality if, for example, the movement is practiced up to speed too quickly.

3. Skill – optimal utilisation and exploitation of external factors eventually occurs after extensive practice (the amount varying with the individual), enabling resourceful achievement of the movement goal whatever the external circumstances (Bernstein, 1984; Gentile, 1998).

Summary of Bernstein's Contribution to this Study's Goals

This review of Bernstein's (1984, 1996) theory of the development of coordinated and controlled movement has suggested the following:

- An understanding of goal-directed movement, or dexterity, as a strategic, contextualised, goal-directed, problem-solving strategy, that, with extensive non-repetitive practice, led to a coordinated and controlled motor system, and
- A learning progression marked by three broad stages of skill advance –
 - i. at lower levels, a reduced set of motor options due to the freezing of many movement aspects, and opportunity to repeatedly solve routine movement tasks in predictable environments,
 - ii. at middle levels, an expanded set of motor options due to the releasing of available movement options, and opportunity to repeatedly solve more complex movement tasks in more unpredictable environments, and
 - iii. at highest levels, resourceful interaction with and exploitation of environmental opportunities for maximum, creative goal outcomes.

Further reflection on Bernstein's insights about how movement was progressively acquired engaged next with the separate fields of human movement study – motor control, development, and learning.

Contributions from the Field of Motor Control

As the study of movement's underlying neuromotor processes, motor control has been an important area of research for the neurosciences, biophysics and engineering professions (Levin, 2014; Summers, 1992). In relation to the interests of this study, consideration will be given particularly to some light motor control studies shed on Bernstein's three-stage skill acquisition sequence.

The goal of motor control research is “to create a formal description, operating with exactly defined variables, of the physical and physiological processes that make movement possible” (Latash et al., 2010, p.1). Bernstein has been considered “the father of motor control” in his posing of the problem of motor redundancy: the infinite number of potentially controllable movement possibilities the neuromotor system offers (Latash, 2012a, p.15). His proposal, that many degrees-of-freedom in movement are first frozen to simplify selection while learning, has been found both helpful and imprecise – how does this freezing take place, and how does restriction of joint motion make movement easier (Latash, 2012a, 2012b; Westcott McCoy & Dusing, 2012)? Studies in support of a theory known as the “uncontrolled manifold hypothesis” have progressed Bernstein's proposal, utilising a perspective of “abundancy” rather than problematic redundancy of degrees of freedom (Latash et al., 2010, p.382; see also Gelfand & Latash, 1998), and an operational and empirically validated meaning of *frozen and unfrozen* degrees-of-freedom as *more and less controlled* joint spaces (Feldman & Levin, 2009; Latash, 2010; Scholz & Schöner, 1999).

Movements are selected on the basis of an end-goal. Multiple synergies, or “families of solutions” entailing multiple joint spaces consistent to achieving that goal initially form into

subsets – more than will ultimately be needed, and these constitute the “uncontrolled manifold” (Latash, 2015, p.291). For example, when learning a sit-to-stand transfer, the joint spaces contributing to stabilisation of the centre of body mass within the sagittal plane are recruited, in other words, they receive preferential neural control to vary synergistically, rather than independently, which is their abundant capability. With practice, all “bad variability” within this group is eliminated, and the movement reaches a first level of competency (Westcott McCoy & Dusing, 2012, p.92). This is then followed (Bernstein’s second stage) by a process that reduces ‘good’ variability; returns greater independent functioning to the maximum possible number of now trained, initially recruited joint spaces so they can flexibly serve concurrent, complementary goals, such as reducing energy expenditure, or managing concurrent tasks. The result is increasingly automatic consistency and resourceful end-goal success, alongside advanced management of competing demands and other challenges. This tightens up Bernstein’s explanation of the first two stages of performance improvement (Latash, 2010, 2012b). However, though not included as its control variables were undefined, Bernstein’s third stage is not rejected (Anson & Latash, 1996; Latash, 1996):

1. The first stage involved two sub-stages – firstly, the recruiting of all joint spaces important to the movement, followed by practice enabling synergies to form within that recruited group, and the movement to stabilise (Latash et al., 2010). At the end of this stage, bad variance is eliminated and the movement is proficient, though likely still containing inefficiencies against secondary goals.
2. Aspects of the movement previously controlled within synergies are released to support greater efficiency against secondary goals, or to expand alternative goal realisations in cases of unexpected or competing requirements. These can now be managed as well as efficient, automatic execution of the movement.

Motor control studies have thus deepened understanding of the motor behaviour, and further refined how advancing acquisition of skilled movement can be conceived.

Contributions from the Fields of Motor Development and Learning

Motor development is an aspect of developmental psychology, with the goal of understanding human nature and underlying cognitive processes through the study of visible behaviour (Adolph & Robinson, 2015; Beek & Meijer, 1988; Mounoud, 1986). Mounoud has noted the similarity of the psychological processes and mechanisms underlying both motor and cognitive skill development, hence it is unsurprising that researchers of both cognitive and motor development have referred to similar major theorists.

Developmental psychology has a long history, with significant changes in dominant theories that have resulted in major revisions to related practice areas, including education and rehabilitation (Berk, 2013; Campbell, 2012). In relation to motor development, a more coarse-grained overview would identify neural maturationist beginnings, followed by critique and correction from dynamic-systems theory and brain plasticity studies (Berk, 2013). A more detailed trajectory will be undertaken here, moving from neural maturationist beginnings, through Piagetian cognitive constructivism – to better understand child active agency and stage-like growth, to information-processing theory, particularly schema theory – to better understand learner engagement and instructional support, and, finally, to ecological and dynamic-systems theories for their perspectives on environmental facilitation (Berk, 2007; Campbell, 2012). These four theoretical bases parallel behaviourist, cognitivist, constructivist, and connectivist learning theories in education (Siemens, 2005). Motor learning evidently intersects with this history, so will not be considered separately. From a neural maturationist pre-history, motor learning has identified and eschewed behaviourist beginnings for presuming learner passivity and promoting externally- controlled intervention, and has significantly sourced both information-processing, or structuralist/functional theory,

for instructional support ideas (Schmidt, 2003; Wallian & Chang, 2006), and dynamic-systems theory for understanding environmental facilitation. Hence, in the following discussion, motor learning will be considered principally in the context of those latter two theories.

Neuromaturation and Nativist Development Theories

Traditional maturationist theories sought developmental norms for the emergence of fundamental motor skills – posture, mobility, and prehension (Sugden, 2007; Thelen & Adolph, 1992), and nativists, such as Fodor (1983) proposed the existence from birth of prespecified input systems, or modules, that explained initial, instinctual responses to incoming data, and how learned control developed (Karmiloff-Smith, 1992). These “software” theories assumed a passive child (Adolph & Robinson, 2015; p.116). Neural development was proposed to follow a cephalocaudal and proximodistal direction, and a genetic timeline, and to precipitate coordinated movement according to prescribed motor milestones (Gesell, 1946; McGraw, 1945; Shirley, 1931; see also Adolph & Berger, 2006; Thelen, 2000). The level of achievement of these milestones at the end of the developmental process was due to the intactness of the neural infrastructure; the environment playing little or no role other than as trigger for development (Adolph & Robinson, 2015; Karmiloff-Smith, 1994). Consistent with this thinking, movement learning could not proceed until the body was developmentally ready. At school entry, with developmental motor milestones reached, teachers could instruct in the 11 fundamental motor skills “most essential for primary school students to master” as they facilitated sports engagement – the catch, kick, run, vertical jump, overhand throw, ball bounce, leap, dodge, punt, forehand strike, and two-hand side-arm strike (Department of Education, Victoria, 1998, p.1; Gallahue & Donnelly, 2003). This focus on formalised movements and technical descriptions of how these should be instructed (Nyberg, 2014), continues in physical education text books that refer to the “mountain of motor

development” (Clark & Metcalfe, 2002, p.179), the “rudimentary movement period”, (Gallahue, Ozmun & Goodway, 2012, p.51), and the necessity to bring reflexive movement under control (Haywood, Robertson & Getchell, 2012).

Subsequent research questioned the extensive infrastructure required at the beginning of development and its static, determinist unfolding, especially considering theories of brain plasticity and indications that development is multi-causal and environmentally influenced (Berk, 2007; Thelen, 1998). Bernstein’s (1984) work had indicated no one-to-one correspondence between muscle actions and movement output but had promoted the importance of considering the influence of the environment on all motor behaviour. Other studies concurred, demonstrating the contribution of practice and the role of environmental opportunity to motor achievement, all which highlighted stark implications for children with physical disability (Campbell, 2012). As noted in Chapter 2, typically developing children, for example, take on average 9000 steps a day, and experience 15 inconsequential falls an hour (Adolph & Berger, 2006; Effgen & Chan, 2010). As well, while a highly domain-specific initial structure such as Fodor’s (1983) could explain early efficiency and automaticity, subsequent flexibility in later development was more difficult to explain (Karmiloff-Smith, 1994). A more active role for the child in development was proposed, a principal exponent for this position being Piaget.

Piaget’s Cognitive-constructivism

Piaget’s (1970, 1971) influential cognitive developmental theory opposed the passivity and determinism of both traditional behaviourism and nativist neuromaturation with an active, constructivist role for the child, contributing to a cognitive revolution focused “more on the mind than the outer workings of the body” (Adolph & Robinson, 2015, p.115) and a greater interest in the roles of physical and social environments in development (Berk, 2007; Karmiloff-Smith, 2007; Miller, 2011; von Hofsten, 2009). Piaget viewed the child as a

sensorimotor organism with no domain-specific predispositions, but as actively engaged upon making sense of chaotic environmental input. Through movement, knowledge about the world developed. General activity and exploration enabled resolution of problems, or equilibration, which lifted development to a new stage across all domains contemporaneously – the theory of “stage-like domain-general change” (Karmiloff-Smith, 1994, p.693). Piaget (1970) proposed four invariant, age-determined stages – sensorimotor, from birth to approximately two years; pre-operational, from two to six to seven years; concrete operational, from six to seven years to 11-12 years, and adult, formal operational thinking emerging from 11-12 years to adulthood. These stages reflected particular ways of thinking, allowing particular interactions with the world, resulting in particular mental perceptions. Thus, the child moved in a progressive and orderly fashion from exploratory, problem-solving movement to abstract thinking capability.

While development required the child’s active participation, for Piaget, the invariant, universal nature of domain-general stage change meant new understanding could not be directly taught or accelerated; in fact, if a child was prematurely taught a concept, they would be “kept from inventing it and consequently from understanding it completely” (Piaget, 1970, p.715; see also Klahr & Nigam, 2004). In education, this prompted a discovery learning approach – providing maximal environmental opportunity for independent development, while ensuring students were not required to absorb information for which they were not developmentally ready (Berk, 2007; Brainerd, 2003; McDaniel & Schlager, 1990). However, other perspectives and research findings challenged this and other aspects of Piagetian theory (Karmiloff-Smith, 1994):

- Vygotsky’s (1978) socio-cultural theory had proposed development was not achieved independently but required more knowledgeable others and properly

organised learning focused on zones of proximal development where progress was most likely.

- Studies into language acquisition demonstrated this achievement in people with cognitive impairment, which should not have been the case if a global level of cognitive capacity was first required (Karmiloff-Smith, 1994).
- Other findings indicated the domain-specific nature of impaired cognitive functioning in some conditions, including autism (Frith, 1989), and acquired brain injury (Marshall, 1984).
- Educational studies demonstrated domain-specific principles guiding learning, while performance differences resulting from different learning experiences better explained the wide variation in capacity in children and adolescents of similar age (Berk, 2007; Klahr & Nigam, 2004; Spelke, 1991).

An alternative theory of cognitive information-processing conceived development as an input-processing-output process, characterised by gradual and continuous developmental learning.

Information-processing Theory and Motor Learning

Information-processing theory developed in the 1970s and 1980s, from the notion that humans process information, and a proposal that the central nervous system's neuronal structures could in some ways be compared to computer software programs, with cognitively-controlled information flows, input-output systems, and functions involving coding, transforming, and organising of data (Berk, 2013; Burgess-Limerick, Abernethy, & Limerick, 1994; Schmidt & Lee, 2011). While in agreement with Piaget's (1970, 1971) theory of the active, cognitive control of learning, information-processing theory conceived capacity development advancing gradually and continuously with practice (Berk, 2013).

Studies demonstrating the importance of practice to motor competency resulted in information-processing theory's extensive utilisation by physical rehabilitation and education (Cross, 1967; Driscoll, 2000; Effgen, 2013; Schmidt, 1991, 2003; Winstein & Kay, 2015; Winstein, Lewthwaite, Blanton, Wolf, & Wishart, 2014). In physical rehabilitation, Winstein et al. (2014) have noted the influential work of Gentile (1972, 1987, 1992) and Fitts and Posner (1967), and in the educational area, Simpson (1966) applied Bloom's (1956) work on educational taxonomies to the psychomotor domain.

Taxonomy 2: Gentile's phases of learning. Gentile's (1972, 1987) conception of stages of learning drew on information-processing theory, conceiving skill learning to be a continuous process but not time-fixed, as conceptualised by Piaget (Karmiloff-Smith, 1986; Shuell, 1990). Rather, with Fitts (1964), phases were "gradual shifts in the ... nature of the processes (strategies and tactics, executive routines and subroutines) employed, as learning progresses" (p.261). Gentile's two-phase model involved:

1. Getting the idea of the movement – a cognitive and exploratory phase, broken into an initial step of organising the motor pattern to achieve the goal – a basic movement plan, then executing it, progressively improving alignment to environmental and task demand (1972). Verbal self-guidance commonly featured during this phase, which concluded with an accurate, environmentally-contextualised movement shape, or program. This, then guided movement execution prospectively, and progressively refined outcomes against intentions.
2. Fixation and diversification. The focus moved to improving the movement in relation to consistent and energy-efficient goal attainment (Gentile, 1987). In consistent-motion closed tasks, or stable environments, this phase was marked by reduced variability and greater automaticity. In open tasks, diversification of movement patterns, environmental monitoring, and problem-solving in changing

situations continued to be conscious and to improve. Overall, various performance-related indicators such as improved energy efficiency and ability to attend to other tasks concurrently revealed progress had reached this level.

Taxonomy 3: Fitts and Posner's motor learning progression. Fitts and Posner's (1967) information-processing work from the learner's perspective conceived of three learning phases:

1. A cognitive first stage, typified by conscious, cognitive effort, slower performance, rule-following, verbalisation of strategies, and variable, trial-and-error performance, with instructors/therapists providing guidance to correct errors (Coker, 2018; Zwicker & Harris, 2009).
2. A second, associative stage, appearing after significant practice, marked by greater consistency, achievement to time requirements, adjustments to environmental requirements, and growing accuracy and ability to attend to other aspects of tasks concurrently. Instructors/therapists provided less guidance, but did provide constructive experiences, allowing the learner to make errors and take responsibility for correcting them.
3. A final, autonomous stage, occurring only after extensive practice, marked by automaticity, consistent success, and little cognitive effort, allowing multiple other tasks to be engaged in.

While again the top-level here featured automatic functioning that was less dependent on cognitive control and conscious processing, other applications of Fitts and Posner's (1967) work conceived of further learning occurring after knowledge achieved that procedural form to tune it to apply more appropriately (Anderson, 1982; Glaser & Bassock, 1989). This expressed something perhaps more akin to the reflective, intentional, and resourceful creativity of Bernstein's third stage.

Taxonomy 4: Simpson's taxonomy of the psychomotor domain. A final conception of staged learning fitting within the information-processing perspective drew from Bloom's (1956) and Krathwohl, Bloom, and Masia's (1964) cognitive and affective taxonomies. These taxonomies (also described as developmental sequences or hierarchical continua) were developed specifically for educational purposes enabling progressive stages to be identified along trajectories ending at domain mastery. Simpson's (1966) acquisitional sequence for the psychomotor domain consisted of five stages:

1. Perception – the ability to use sensory cues to guide activity and select responses,
2. Set – the ability to ready oneself mentally, physically, and emotionally to act, to fashion a movement response and to actively attempt movement,
3. Guided response – the ability to imitate another's movement, to engage in trial and error movement, and to practice,
4. Mechanism – the achieving of habitual movement, and execution of whole movement tasks with some proficiency, and
5. Complex overt response – the ability to move quickly, accurately and with coordination, in complex tasks, achieving automaticity to the highest level required.

Again, automaticity indicated mastery, however Simpson (1966) considered the possibility of a sixth category, called 'adapting' or 'originating', involving the invention of movement solutions to meet special requirements, or the demands of specific problems or contexts. Here again, a more intentional top end alternative was considered.

Challenges to information-processing. Challenges to the cognitive information-processing approach of theorists such as Fitts and Posner (1967) and Schmidt (1975) proposed it was dependent on philosophical dualism in the requirement of cognitively pre-programmed and stored order and regularity structures (Abernethy & Sparrow, 1992; Araújo & Davids, 2011; Aune, Pedersen, & Ingvaldsen, 2008; Burgess et al. 1994; Dreyfus &

Dreyfus, 1988; Schmidt, 2003; Spencer, Perone, & Buss, 2011; Summer & Anson, 2009).

Dualism conceived the mind separate from the body and the environment, and the body as the “tool of the mind” (Wallian & Chang, 2006, p.293). Because of this separation, goal-directed movement had first to be represented in the mind, and the environment indirectly perceived, before action took place (Abernethy, Burgess-Limerick, & Parks, 1994). However, studies challenging an interpretation of cognitive representationalism in sports education research and adult skill acquisition more generally, drew attention to the intuitive, immediate, and non-cognitive nature of expert performance, and the explanatory power of systems thinking for the experience of automaticity (Abernethy et al. 1994; Dreyfus & Dreyfus, 1986, 1988). An alternative understanding of motor learning - the development of neural biases towards preferred movement shapes (Schöner, 2009) - was proposed by dynamic-systems theorists, who also took up Gibson’s (1979) important ecological psychology perspective (Araújo & Davids, 2011; Kaplan, 2010; Pick, 1989; Sugden, 2007; Schmidt & Lee, 2011; Thelen, 2000).

Ecological Psychology

Gibson’s (1979) ecological psychology theory proposed that movement resulted from the direct perception of an environment’s utility, or “affordances” for action (p.119; see also Pick, 1992). Movement first generated information, which supported further movement, in a cyclic process between perception and movement – “we must perceive in order to move, but we must also move in order to perceive” (Gibson, p.223; see also Davids, 2010). As opportunities afforded by the environment were not static, movement required the reciprocal environment-perception-action system capable of end-state planning that adaptively anticipated and guided movements in real time to meet goal requirements. In Gibson’s theory, there was no mind-body or subject-object duality between self and world, and no unique integrating centre, consequently no direct sequencing first processing perceptions, then deciding and directing action (Adolph & Robinson, 2015). Rather, “actions are

realisations of what the environment affords an animal” (Reed, 1982, p.101). While containing similarities to Bernstein’s (1984) functional systems theory, ecological theory extended beyond Bernstein’s theory in this more radical, direct perception proposal.

As an ability to “look at, touch, step into, reach forward, hold, and shape the world” means the world offers an irresistible invitation to do so (Kielhofner, 2008, p.14), so students with physical disability would perceive most classroom environments as affording fewer opportunities for action, and consequently for problem-solving, reasoning and remembering; cognitive skills that arise with and depend on perception (Gibson & Pick, 2000). Ecological theory thus encouraged matching physical abilities of students to affordances for action in the classroom – creating environments and tasks that invited ability-scaled action and contextual problem solving – an indirect teaching approach like discovery learning – called task-environmental design (Rukavina & Foxworth, 2009).

The Dynamic Systems Approach

Thelen (1992; Thelen & Smith, 1996, 2006) conceived a merger of Bernstein’s proposal for the resolution of motor redundancy, and ecological psychology’s self-world reciprocity. Systems theory provided an alternative explanation for how skilled movement developed (Davids, 2010; Thelen & Bates, 2003). It presented humans as complex neurobiological systems, and the human body as a dynamic, open, and integrated system of great complexity that freely related to its social and physical world in nonlinear ways (Berk, 2007). The movement system was not prescribed by the nervous system, but was “metastable”, or dynamically stable (Davids et al., 2008, p.88). Coordination patterns emerged and dissolved as needed, in a process of “soft-assembly”, involving an embodied cognitive system and the requirements of task and environment (Schöner, 2009; Spencer, Corbetta, Buchanan, Clearfield, Ulrich, & Schöner, 2006; Spencer et al., 2011; Thelen & Ulrich, 1991). This involved movement synergies assembling around preferred attractor states – movement

outcomes that were the most stable, comfortable, and energy-efficient (Kugler & Turvey, 1987; Thelen, 2000; Thelen & Bates; Thelen & Smith, 1996). Motor skill advanced further when stable patterns failed in the face of new requirements, which led to behaviour reorganising at a more complex level (Rosenbaum, 2010). Through ongoing adaptation to different constraints and affordances as they emerged, dynamic stability and flexibility across many changing environments resulted (Thelen & Smith, 2006; see also Campbell et al., 2012; Davids, 2010; Newell, 1986; Newell et al. 2003).

The concept of learning contained in the dynamic systems approach was consistent with embodied and extended cognition understandings – the deep dependence of cognitive processing on the features and actions of the physical body and environment (Wilson & Foglia, 2011). Embodied cognition provided explanation for experiences of automaticity in advanced movement (Poldrack, Sabb, Foerde, Tom, Asarnow, Bookheimer, & Knowlton, 2005) and challenged dominant computational and representational theories of the mind that assumed hierarchical cognitive control. This less cognitively directive, more dynamically responsive model of motor skill acquisition was reflected in a final taxonomy – that of Dreyfus and Dreyfus’ stages to skill mastery (1986).

Taxonomy 5: Dreyfus and Dreyfus’ model of skill acquisition. Dreyfus and Dreyfus’ (1986), concerned with an information-processing view of skill as “calculative rationality” (p.193), conceived a five-stage progression incorporating dynamic-systems features:

1. Novice – rules guided actions for beginners attempting skills for the first time. Before discretionary judgement developed, context-free rules were followed literally.
2. Advanced beginner – enough standard situations had been met that important aspects were comprehended; however, all aspects were treated as of similar importance.
3. Competent – after extensive real-life experience, action choices were placed within longer-term perspectives, so it was easier prioritising in complex situations.

4. Proficient – automatically correct actions were selected quickly in all but unusual circumstances, drawing on a holistic understanding of the situation.
5. Expert – exemplified by intuitive movement know-how and instantaneous adaptation both effortless and invariably right – “an expert’s skill is so much part of him that he is no more aware of it than his own body” (Dreyfus & Dreyfus, 1986, p.30).

Critique of dynamic-systems theory in movement studies noted a tendency to a contrived study of movement in laboratory settings, isolated from real-life (Schöllhorn, 2003), and greater attention to the acquisition of habitual, repetitive movement patterns, such as underlie walking, than the discrete, complex, non-repetitive skills required for operating a keyboard, for example, or managing an intricate woodworking project (Keele, 1998; Summers & Anson, 2009). The former movement skills, according to Bernstein (1996), were easier to acquire, constituting foundational performance aspects upon which more situation-specific and novel movement abilities were conceived and developed. Therefore, a perception of limited utility of dynamic-systems theory for educational/ motor learning agendas has followed this critique (Schmidt, 2003), possibly also arising from the theory’s commitment to notions of embodied cognition and tacit knowing – knowledge that resists being made explicit (Jaubowska, 2017; Polanyi, 1966). In addition, a failure-driven conception of progress has been seen as insufficiently descriptive of human development, which follows success with further advancement (Karmiloff-Smith, 1992).

A summary of the taxonomies of motor skill advance outlined in this chapter is provided in Table 6, followed by broader reflections in relation to the interests of this study.

Table 6 *Summary of Psychomotor Taxonomies*

Proponent	Theoretical underpinnings	Stages	Features of progress	Role of cognition in motor mastery
Bernstein, 1996 (see also Latash, 2012, Newell, 1985)	Social-constructionism (Vygotsky), later expressed in ecological, dynamic-systems and cognitive information processing theories of motor learning	3	<u>Early</u> – concentration and practice, achievement of a first level of basic proficiency in routine tasks; <u>Mid-stage(s)</u> – improvement often abrupt and includes temporary setbacks. Refinement brings more automatic efficiency	<u>Highest levels</u> – <i>conscious</i> , cognitive strategizing and creativity, resourceful, intelligent use of the body to maximise and extend possibilities
Gentile, 1972	Cognitive information-processing theory and Bernstein's social constructionism	2	<u>Early</u> – cognitive, exploratory engagement, basic movement plans devised and consciously executed, gradual improvement occurs. Refinement brings more consistent, economical movement and automaticity in closed tasks	<u>Highest levels</u> – open tasks and unpredictable, changing environments draw on <i>conscious</i> problem-solving skills
Fitts and Posner, 1967	Cognitive information-processing theory	3	<u>Early</u> – conscious, cognitive effort, rule-following, basic movement goals are achieved; <u>Mid-stage</u> – gradual improvement occurs – outcome of many variations of movement encountered	<u>Highest levels</u> – movement is <i>automatic</i> (though a proposed additional stage involves ongoing conscious tuning of movement)
Simpson, 1966	Cognitive information-processing theory	5	<u>Early</u> – movement opportunities perceived, body readied, conscious trial and error learning takes place; <u>Mid-stages</u> – gradual improvement occurs to a point of relative proficiency	<u>Highest levels</u> – movement is coordinated and <i>automatic</i> even in complex situations (though a proposed additional stage involves consciously inventive movement to meet special demands)
Dreyfus and Dreyfus, 1980	Dynamic systems theory	5	<u>Early</u> – before experience or discretionary judgement has developed, rules are followed literally; <u>Mid-stages</u> – gradually, through meeting more situations, automaticity and multi-tasking develops	<u>Highest levels</u> – movement is <i>automatic</i> , intuitive, and invariably right

‘Representative Redescription’ and the Role of Cognition in Motor Mastery

As previously noted, the skill progressions presented in Table 6 evidence some contrast of events at the highest levels – on the one hand, mastery involves (non-cognitive) automaticity (Dreyfus and Dreyfus, 1980; Fitts & Posner, 1967; Simpson, 1966), on the other, intelligent, resourceful use of the body, and more active and reflective (cognitive) control (Bernstein, 1996; Gentile, 1972; Latash, 2012b; Newell, 1985, and the alternative final stages of Fitts & Posner, 1967, and Simpson, 1966). These two options reflect an ongoing controversy in the literature between dynamic-systems and cognitive-hierarchical approaches (Abernethy et al., 1994; Aune et al, 2008; Karmiloff-Smith, 1992; Latash & Anson, 1996; Mechsner, 2004; Reed, 1982; Schmidt, 2003; Shea & Wulf, 2005; Summers, 1992, 1998). The dynamic systems approach has understood movement in animal action-systems to occur via distributed, non-centralised control, and skill development to result from the strengthening, through frequent use, of those patterns the system finds easy, and therefore prefers (Thelen & Bates, 2003). Individual differences in capacity, according to this understanding, refer to differences in intrinsic dynamics, the result of differences in organic and historical factors that impact all possible interplays along the development pathway, and hence the outcome (Thelen & Smith, 1996). The cognitive hierarchical approach, on the other hand, has emphasized the anticipatory and planned nature of movement – humans initiate, they don’t simply react to events; and has theorised that this requires anticipatory schema and internal models of the external world within which movement possibilities are generated (Jeannerod, 1997). Both perspectives have referenced Bernstein – the former for his systems-like resolution of the degrees-of-freedom problem, the latter for his (1967) proposal of internal models of action for habituated movements, and argument for the brain’s active independence – “the human brain is able to undertake actions whose sources are confined within the brain itself” (Anson & Latash, 1996, p.94). Anson and Latash have argued that

these perspectives do not need be in competition, but are better combined into one framework, pointing out that what Bernstein opposed was the Pavlovian idea of a purely reflexive mind.

A cognitively oriented approach that does not deny dynamic-systems features and the idea of skill leading to non-cognitive automaticity, but has proposed that it is conscious, cognitive engagement with developmental change that makes for specifically human development, is that of Karmiloff-Smith (1981, 1992, 1994). According to her theory of “representative redescription”, development involves processes of internal reorganisation through three recurrent phases, “by which information in the cognitive system becomes knowledge to that system” (Karmiloff-Smith, 1992, pp1-2). Development does not finish with automatic and efficient learning, equating to Bernstein’s first level of basic efficiency, but humans spontaneously go beyond successful environmental interaction and seek understanding and the creation of intra-domain and inter-domain relationships that contribute to knowledge accessible for new uses and theory-building (Karmiloff-Smith, 1992). The phases have been described as follows:

1. Information from the external environment drives initial skill learning, and a stage of gradual proceduralisation follows, resulting in behavioural mastery that is automatic, but not accessible for other purposes.
2. An internally driven process occurs, where the features of the external environment are disregarded temporarily for the sake of achieving greater understanding of what has been achieved. This likely results initially in an increase in error and inflexibility – a drop in successful behaviour (or a “U-shaped developmental curve” – Karmiloff-Smith, 1992, p.19), while representational understanding continues to increase, resulting in capability that is more abstract, less specialised, but more flexible and

productive of new forms and uses. Across this stage, *conscious* access to new forms of knowledge grows, but cannot yet be explained in words.

3. The knowledge within the skill reaches abstract coding level, becoming communicable and able to be linked with other knowledges coded differently. At the same time, the skill at its earlier level remains available for whole, intact use if needed – development thus drives for redundant richness, not economy.

Importantly for this study, this process –

- Involves stages, or phases, of development, rather than a single ‘arrival’ point, hence, supporting a learning progression approach,
- Involves growth in understanding that increases usability of existing knowledge – hence, supporting an inclusive approach focused on maximising the usability of each student’s unique movement knowledge,
- Contrasts with views of development as failure-driven, for, while ‘in-phase’ growth may be spurred by failure’s negative feedback, qualitative ‘phase-transition’ follows success – a stable state is needed before knowledge can be re-appropriated, and this supports positively described scales, and
- Proposes that in the acquisition of a skilled motor system, cognitive internal reorganisation continues to drive growth throughout, not only at beginning stages.

The literature has also indicated that while a dynamic-systems perspective can adequately explain motor control and learning in automated, repetitive movement tasks, a cognitive approach better supports the learning of discrete and complex movements involving strategy formation (Abernethy et al., 1994; Abernethy, Thomas & Thomas, 1993, Keele, 1998, Schmidt, 2003; Summers & Anson, 2009). In conclusion, the classroom is a complex environment for motor performance, involving both routine actions and complex, adaptive and innovative motor skill. To function physically in the classroom entails capacity in both

areas, to achieve complex, fine-motor requirements, movements that meet time constraints, new movements that are part of new learning, movement combined with the simultaneous execution of other tasks, varying navigational requirements in small spaces, and accommodation to the movements and requirements of others. Therefore, it is proposed that a motor skill learning progression for the classroom should reflect both automaticity and resourceful, cognitive processing at higher levels. Figure 5 summarises this chapter's review in proposed key features of a (vertical) motor learning progression –



Figure 5. Proposed developmental progression for goal-directed movement

The previous review has supported Bernstein's conception of movement as a goal-directed, solution-finding strategy for overcoming the problem of infinite degrees-of-freedom, that produces a controlled and coordinated motor system:

- Motor control studies proposing that the coordination and control of the motor system occurs in at least two stages, beginning with an elimination of bad variance, and then further streamlining through elimination of unnecessary good variance (Latash 2012b, 2015).
- Gentile's (1987) 'strategy' description of movement, and concept of "motor equivalence" drawing from Bernstein's insight that "movement patterns are not reducible to one fixed mode within the central nervous system" (p.97)
- Rehabilitation developing inter-trial variability principles from Bernstein's conception of movement as repetition without repetition (Winstein & Kay, 2015).
It is because skilled movement entails bringing about the same outcome in constantly changing circumstances that problem-solving is central to the definition, and assessment and learning must take place in real situations.
- Finally, dynamic-systems theory advancing motor development theory through utilisation of Bernstein's conception of non-prescriptive movement and the notion of situational, or "soft-assembly" recruitment and organisation of synergies to conceive of motor development as emerging from the practicing activity of the child, rather than from "magical maturational processes" (Thelen & Smith, 1996, p.279).

At this stage, this chapter has proposed, firstly, Gentile's (1987) categorisation of movement *strategies* as supportive of positive movement description for students with motor performance needs. Secondly, a complimentary definition of goal-directed movement as bodily *problem-solving* or *solution-finding*, drawing on Bernstein's (1984, 1996) insights, has

been set forward. Thirdly, a body of research in motor control, motor development, and motor learning has been reviewed for understandings of how goal-directed movement is progressively achieved – Master’s (2013) *vertical* dimension of learning domains, with the result of a proposal of qualitatively advancing proficiency levels. The next section considers the *horizontal* dimension of goal-directed movement – its important aspects and indicative skill suggestions.

Aspects and Skills in the Movement Domain

Aspects

Classification of the complex movement domain into sub-dimensions has been common in movement science literature, including that of paediatric physical assessment and rehabilitation. An example is Gentile’s (1972, 1987) breakdown of movement into reflexive and goal-directed types, the latter divided into orienting and adaptive motor patterns, the consequent latter divided into indirect (communicative) and direct (changing/maintaining position of self and/or objects) aspects – see italicised items in Figure 6 (noting Gentile’s interest was in direct movements only):

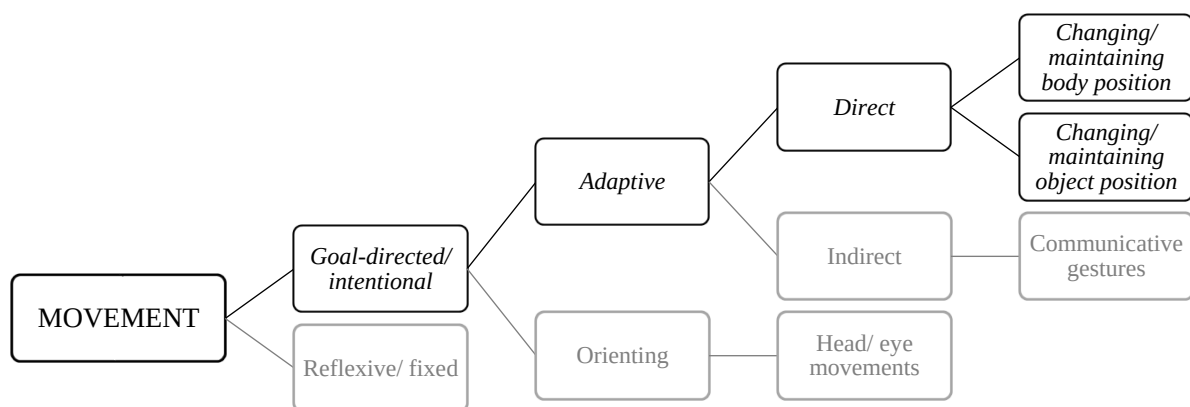


Figure 6. Gentile’s (1972, 1987) categorisation of movement

In educational measurement literature, also, the multidimensional nature of curriculum domains has been recognised (Pellegrino, Chudowsky, & Glaser, 2001; Reckase, 2007), and the need to consider this when making inferences about learning growth (Young & Ye Tong,

2015). Finally, item-response theory has developed a range of multidimensional models, noting that identification of sub-components helps explicate latent traits without jeopardising unidimensionality (Adams et al., 1997; Reckase, 2007; Wu & Adams, 2007). Such skill clusterings support identification of different patterns of motor performance and help to ensure comprehensive appraisal of abilities and difficulties ahead of planning intervention responses (Palisano et al., 2012; Shumway-Cook & Woollacott, 2012; Westcott McCoy & Dusing, 2012; Wilson, Kaplan, Crawford, Campbell, & Dewey, 2000). These divisions have included:

- Two/ three aspects – either a very broad division into gross-motor and fine-motor skills – see Gentile’s (1972) adaptive, direct movements, also common in the physical education literature (Gallahue et al., 2012; Piek, Baynam, & Barrett, 2006; Piek, Dawson, Smith, & Gasson, 2008), or the gross-motor category is further divided into balance and mobility, producing the three “basic actions” of posture, mobility, and manipulation (Newell, 1991, p.215; Newell & James, 2008; Shumway-Cook & Woollacott, 2012; Utley & Astill, 2008), and
- Three/ four aspects – either adding strength/ endurance skills to the three-way division (Fisher et al., 2007), or retaining postural control and mobility in one aspect to produce a comprehensive three-way structure, consisting of skills for:
 - i. maintaining and changing bodily position,
 - ii. maintaining and changing the position of objects, and
 - iii. managing and maintaining physical engagement (Bernstein, 1996; Tiden, Lundqvist, & Nyberg, 2015).

Bernstein (1996) categorised movement in various ways, including recognition of different dexterity profiles, and a multi-level description of movement. Dextrous body and hand use were in the highest of the four levels (Level D) – that of intentional movement, or

meaningful action involving the use of tools, equating to the basic action of manipulation. At lower levels, skills supporting goal-directed movement through space and in consideration of the environment (Level C), repetitive locomotor skill (Level B), and tone and static and dynamic balance (Level A) expressed the basic actions of posture/ balance and mobility, with an additional consideration of strength/ speed/ endurance as a more purely physical aspect of movement behaviour. Bernstein's insights thus underlined the relative difficulty of motor tasks in the classroom – the extent of requirement for 'high-level', psychophysical performance and Level 'D' use of tools (McMurray, Drysdale & Jordan, 2009; Montgomery, 2007; Sugden, Kirby & Dunford, 2008).

Of interest to this study are classifications describing task-related movement usefully for classroom settings – this coheres with top-down descriptions (Trombly, 1993), such as those of the ICF (WHO, 2001, 2007; see also Chien & Brown, 2017; Kolehmainen, 2010; Rodger & Ziviani, 2006) that situate movement ability as one aspect in activity achievement. However, amidst concerns with bottom-up reductionist approaches that only categorised within-child movement deficits (Trombly; Kreider, Bendixen, Huang, & Lim, 2014), a combination has been noted as important for understanding performance needs (Chien & Brown, 2017; Doucet & Gutman, 2013; Kennedy, Brown, & Stagnitti, 2013; Tam, Teachman, & Wright, 2008). Reference to both is also evident in ICF-linked scales, such as the 12-scale Australian Therapy Outcome Measures for Occupational Therapy (AusTOMS-OT) (Perry et al. 2004; Unsworth, 2005), which has included the following five aspects relevant to classroom movement:

1. Transfers (Body functions/ structures), incorporating balance and positioning skills,
2. Functional walking and mobility (Body functions/ structures, Activities),
3. Upper limb use (Body functions/ structures, Activities), incorporating motor skills for gestural communication/ interaction,

4. Learning and applying knowledge (Activities and Participation), incorporating motor skills for handwriting, and
5. Carrying out tasks and routines (Activities and Participation) – a combined activity.

Incorporation of these five scales into the subdivisions already noted suggests the following expansion of Table 7 into five areas most comprehensive of classroom requirements:

Table 7 *Proposed Aspects of the Classroom-related Motor Skills Domain*

Classroom-related Movement Aspects:	Proponents:		
	Bernstein	Gentile	ICF
1. Postural control/ balance	<i>Postural tone, balance underlies all movement (Level A)</i>	Maintaining/ changing body position (for orientation and movement)	Transfers, Functional walking and mobility, and Carrying out tasks and routines
2. Mobility	Mobility and other gross-motor synergies (Level B), and orienting and operating in space (Level C)		
3. Manipulation	Hand dexterity, tool use (Level D)	Maintaining/ changing object position	Carrying out tasks and routines, and Upper limb use, Handwriting
4. Communicative/ interactive skills	-	Communicative gestures (<i>though not further considered in Gentile's work</i>)	Communicating (gestural), Upper limb use, Handwriting
5. Performance sustainment	Strength, speed, endurance	-	-

To further inform these aspects, an additional search was undertaken of paediatric motor function assessments with established validity and reliability currently recommended for use in Australian schools (Independent Schools Victoria, 2014), and/or in common, current

(2007-2017) use (Alotaibi, Reed, & Nadar, 2009; Aslam, van Bommel, Southwood, Hackett, & Jester, 2015; Bagatell, Hartman, & Meriano, 2013; Hanna, Russell, Bartlett, Kertoy, Rosenbaum, & Wynn, 2007; Piernik-Yoder & Beck, 2012). While the basic actions of posture, mobility, and manipulation (Newell, 1991) were commonly referenced, there was also expansion to include strength, endurance, and other aspects related to sustaining performance. The results were as follows:

- *Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition (BOT-2)* (Bruininks & Bruininks, 2005) – a standardised gross- and fine-motor test of 36 items used to screen for motor impairments and plan and evaluate interventions (Brahler, Donahue-Fillmore, Mrowzinski, Aebker, & Kreill, 2012). The BOT-2 consists of four motor area composites, each with two aspects – a) fine manual control (precision and integration), b) manual coordination (manual dexterity and upper-limb coordination), c) body coordination (bilateral coordination and balance), and d) strength and agility (running speed and push-up strength).
- *Peabody Developmental Motor Scales, 2nd edition (PDMS-2)* (Folio & Fewell, 2000), a commonly used standardised test for assessing mild motor difficulties in children from birth to six years that consists of two norm-referenced scales for gross motor and fine motor performance.
- *Movement Assessment Battery for Children, 2nd edition (MABC-2)* (Henderson, Sugden & Barnett, 2007), one of the most widely used performance-based motor skill assessments (Brown & Lalor, 2009), that covers three aspects – manual dexterity, aiming and catching, and balance.
- *School Assessment of Motor and Process Skills (School AMPS)* (Fisher et al., 2007), a standardised and internationally used occupational therapy tool for assessing schoolwork task performance in classroom settings, developed using

item response theory (IRT) (Fisher & Merritt, 2010; Munkholm, Berg, Lofgren & Fisher, 2010). The skills assessed are described as “the smallest observable units of occupational performance” (Munkholm et al., p.769) and are classified into two over-arching scales – motor and process skills. Motor skill aspects include body positioning, obtaining and holding objects, moving self and objects, and sustaining performance, and process skills include applying knowledge, temporal organisation, organising space and objects, and adapting performance. These latter express refinements of movement, or advanced movement know-how, in ways paralleling Bernstein’s (1996) psychophysical category of dexterity, rather than being additional physical capacities.

- *School Function Assessment (SFA)* (Coster et al., 1998; Coster, Mancini & Ludlow, 1999), a criterion-referenced assessment covering cognitive and physical requirements of school participation. The aspects of physical functioning are travel, maintaining and changing position, manipulation with movement, using materials, set-up/clean-up, up/down stairs, written work, and computer use.

The aspects considered in these assessments can be logically accommodated within four of the five Bernstein/ Gentile/ ICF categories, as shown in Table 8:

Table 8 *Aligning Assessments to Aspects of Classroom-related Movement*

Classroom-related movement aspects:	Assessments:				
	BOT-2	PDMS	MABC-2	School AMPS (motor)	SFA
1. Postural control/ balance	Body coordination; Strength and agility	Gross-motor	Balance	Body position	Maintaining and changing position; Travel; Up/ down stairs
2. Mobility (moving self and objects)			-	Moving self and objects	
3. Manipulation	Manual coordination, Fine-motor	Fine-motor	Manual dexterity; Aiming and catching	Obtaining and holding objects	Manipulation with movement; Using materials; Set-up/ clean-up; Writing; Computer use
4. Communicative/ interactive skills	-	-	-	-	-
5. Performance sustainment	Strength and agility	-	-	Sustaining performance	-

While a communication/ interaction category was not identified by these assessments, its consideration as a movement category is supported by research interest, including the body's role in expressing emotion (Argyle, 1975), and thought (McNeill, 1992), and the role of non-verbal communication in learning (Goldin-Meadow, 2004, 2006, 2010). Reed's (1982) influential ecological studies of motor behaviour included the 'expressive system' as one of the eight human action systems – "coalitional structures of adjustable movements and postures" (p.98) that underlie all human activity, and, in the Australian context, expressive communication had been noted as a classroom-related skill impacted by physical disability (DET, 2017). Communicative gesture has also been incorporated into a recent comprehensive manual abilities classification and assessment of children's hand skills (Chien, Brown, & McDonald, 2009, 2010, 2011). Hence, the proposal to extend the three

basic actions (posture, mobility, and manipulation) to five aspects comprehensive of classroom-requirements as follows, includes the motor aspects of communication and interaction:

1. Postural control,
2. Mobility (self and objects),
3. Manipulation,
4. Communicative/ interactive skills, and
5. Performance sustainment.

Extending from Figure 4, the structure of the framework for constructing a learning progression developed thus far is provided in Figure 7:

Proposed levels of increasing skill ↑		...								
	...		...							
	...									
		...								
	...		...							
		...	...							
Aspects and skills →	<i>Skill 1</i>	<i>Skill 2</i>	<i>Skill 3</i>	...						
	Postural control		Mobility		Manipulation		Communicative, interactive skills		Performance sustainment	

Figure 7. Proposed framework for developing a movement learning progression

Having proposed main aspects, or dimensions of classroom-related movement, the next section considers indicative skills within each of these dimensions in turn.

Skills

There are an almost innumerable number of items which could be conceived to express the general development of a domain, and an exhaustive list risks assessor fatigue (Gillis, Dulhunty, Wu, Calvitto, & Pancini, 2013). What is important is a sufficient number to provide evidence for inference and to confirm the skill order (Wright and Masters, 1982). In this study, a review was conducted of the literature to identify classroom-relevant motor skills

within the five aspects consistent with the concept of bodily *problem-solving* and providing descriptions at the *strategy-level*. In other words, the skills to be tabled were to be observable and teachable in the classroom and permit motor equivalence in their achievement, rather than being descriptions of single, ‘correct’, normative movement forms – for example – ‘obtaining objects’ rather than ‘bimanual manipulation’, and ‘moving from place to place’ rather than ‘walking’.

Postural control. Bernstein (1996) noted the fundamental role of tone to all movement. “Background of all backgrounds”, his Level ‘A’ in the construction of movement, tone enabled upright posture, and was required for motor coordination (p.115). Later research has noted postural control deficits as a major factor in gait disorders (Rose, Wolff, Jones, Bloch, Oehlert & Gamble, 2007), and in upper limb deficits affecting reach, grasp and prehension (Schneiberg, McInley, Sveistrup, Gisel, Mayo & Levin, 2010). The Berg Balance Scale (Berg, Maki, Williams, Holliday, & Wood-Dauphinee, 1992) measures balance in relation to functional tasks such as transferring, standing, reaching forwards, reaching to the floor, turning, and stepping (Kornetti, Fritz, Chiu, Light, & Velozo, 2004), with this recognition of the supporting role of balance also reflected in other motor assessments, for example:

- the BOT-2 (Bruininks & Bruininks, 2005) evaluates balance in relation to the requirements of participation in sports and recreational games (Wuang, Lin, & Su, 2009),
- the MABC-2 (Henderson et al. 2007) evaluates balance during mobility tasks,
- the SFA (Coster et al. 1998) considers balance in the context of positioning oneself – both maintaining and changing position,
- the School AMPS (Fisher et al. 2007) evaluates balance during execution of table-top classroom activities, relating balance to optimal positioning for task engagement, and

- the child-report Activities Scale for Kids (ASK) asks children to evaluate their balance in relation to sitting independently on the floor, keeping balance in rough games, stretching to reach up high, and standing still for an extended period – all tasks relevant to classroom and school settings (Bagley, Gorton, Bjornson, Bevans, Stout, Narayanan, & Tucker, 2010).

More detailed analysis of balance and what it involves was found in research studies. Assaiante's (2005) study of the development of postural control noted that while tonal adjustment was typically involuntary and unconscious, once children had built a repertoire of postural strategies, they learnt to select the most appropriate strategy, based on correct anticipation of the consequences of movement. This study referenced typically developing children; however, Shumway-Cook and Woollacott (2012) have noted a similar, but more complex process taking place in children with physical disability, with a hierarchy of strategies actively used to counter loss of balance. Westcott McCoy and Dusing (2012) have noted the need for a cooperative interaction of sensory and motor systems to achieving anticipatory self-management of postural stability and that this is an acquired skill, rather than one brought about simply by physiological maturation. Maisson (1994), in examining the role of the postural system in orienting and positioning the body for activity engagement, has also noted the need to filter out irrelevant cues and achieve flexible responses to perturbation during voluntary movement. From this brief review, maintaining balance and postural stability during functional tasks and positioning appropriately for activity engagement are suggested as examples of observable, important, and classroom-teachable skills.

Mobility (Transporting self and objects). Gross motor skills involve the use of large musculature to achieve movement goals (Magill & Anderson, 2014). According to Bernstein (1996), large muscle synergies (Level ‘B’) undergirded and enabled all consecutive, background, locomotor movements that, over time and accumulation of many varying experiences, became more internally and automatically consistent and harmonious. Studies have shown the correlation of locomotion with spatial cognition (Oudgenoeg-Paz & Rivière, 2014), the role of self-locomotion in spatial exploration and spatial memory (Oudgenoeg-Paz, Leseman & Volman, 2014), and a close association of gross motor skill with cognitive processing speed and working memory (Piek et al, 2008), and academic learning (Berthenthal, Campos & Barrett, 1984; Klinkenborg, 2011; Son & Meisels, 2006; Westerndorp, 2014). Foundational mobility then provides support for more complex, intentional movements of the body in interaction with space – Bernstein’s Level ‘C’ movements. These latter are not smooth and repetitive, but frugal and brief – involving purpose, precision, and coordination of response to sensory input, to achieve variations of mobility such as climbing stairs, transferring with the help of objects, and more difficult balancing and managing of self-space during cooperative navigation through crowded spaces and around obstacles.

While basic mobility and transfer skills are acquired through many opportunities for self-initiated movement as children grow, opportunities for such movement are often greatly reduced for children with disability (Egilson & Traustadottir, 2009a), leading to global deprivation that can impact the whole of life (Case-Smith and O’Brien, 2015; Missiuna & Pollock, 1991). This is true not only in the case of severe or profound physical disability, but in the case of more mild conditions, such as Developmental Coordination Disorder (DCD), where motor clumsiness and slowness to learn motor skills reduces involvement in movement activities (Magalhães, Cardoso, & Missiuna, 2011; Poulsen, Ziviani, Johnson & Cuskelly, 2008), or in Down syndrome, where more good variability is retained to stabilise gait in the

context of lax joints and low muscle tone (Westcott McCoy & Dusing, 2012). In research on the occupational performance needs of school-aged children with disability, Case-Smith and O'Brien (2015) found independent mobility to be the greatest need and area of concern, underlining the importance of addressing this in the school context. Important learning aspects that have been identified in research reviews on physical disabilities are sequence learning and sensorimotor adaptation (Bo & Lee, 2013) and abilities to perceive, recall and plan for movement (Westcott McCoy & Dusing). The classroom-related skills suggested by this brief review include not only basic mobility – moving the body from one place or position to another and transporting objects while moving, but also responding appropriately to sensory cues, for example, in avoidance of obstacles, and remembering movement sequences to make an appropriate movement response.

Manipulation. Hand dexterity and object manipulation and use are key features of Bernstein's Level 'D' – the human level of meaningful action, involving movement with two key features – a "chain structure", where an overall complex movement is achieved by "rows of consecutive events of different meaning and purpose"; and "adaptive variability" – the making of unique, minute adjustments to external conditions that are never the same (Bernstein, 1996, p.147). Classroom tasks, and particularly handwriting, call upon these skills, and the exercise of these skills furthers classroom learning. Studies have shown that development of perceptions of shape, texture and mass take place through fine-motor exploration and manipulation of objects (Case-Smith & O'Brien (2015), compositional fluency develops as handwriting proficiency improves (Wallen, Duff, Goyen, & Froude, 2013), and skill in the secretarial aspects of writing (the motor aspects of text creation – letter formation, positioning, orientation, spacing, regularity, consistency, ease of production and legibility) supports the creation and expression of more complex meanings, and makes available more working memory for higher-level processes of planning and revising

(Boscolo, 2008; Christensen, 2009; Graham, 2009). Because of this level of significance to the occupational role of ‘learner’, and in recognition that students with physical disabilities can be significantly disadvantaged if not supported to develop these capacities, paediatric occupational therapy literature is replete with attention to this area (Asher, 2006; Bayona et al., 2006; Case-Smith, 2000; Cramm & Egan, 2015; Hammerschmidt & Sudsawad, 2004; Hoy et al., 2011; Wallen et al, 2013, Wehrmann, Chiu, Reid, & Sinclair, 2006). Classroom aspects requiring manual ability include using writing and learning tools and equipment, managing personal school belongings, and using games and activity equipment.

Communicative/ interactive skills. Another aspect of Bernstein’s body dexterity is the ability to communicate intention and express feeling using the body – predominantly involving expressive actions of the hands and arms that accompany speech, but also facial expressions (Bernstein, 1996). Basic facial expressions are semi-voluntary and not learnable as such, but other communicative/ interactive actions are more complex and involve learning, including movements supporting social interaction (Carson, 2016; Leonard & Hill, 2014; Sigafoos, Woodyat, Keen, Tait, Tucker, Roberts-Pennell, & Pittendreigh, 2000), and capacities that enable reliable communication of nuanced meaning. Such skills have been included in Dance curricula, which assesses and instructs elements such as breath, emotional expression and regulation, use of body in space, relaxation and release of physical tension, sustaining social connection, appropriate physical connection and appropriate give and take, and energy attuned appropriately and focused on activity (see, for example acara.edu.au; Castañer, Torrents, Anguera, Dinușova, & Jonsson, 2009; Dunphy & Mullane, 2017; VCAA, 2015).

Non-verbal communication has been called “the hand’s role in talking and thinking” (Goldin-Meadow, 2006, p.336), with research indicating that gesture provides children with speech-language difficulties with workarounds to language difficulties, and conveys

substantive meaning, giving insight into mental representation (McNeill, 1992). More significantly, there is evidence that non-verbal communication helps shape thinking and improve learning ability (Broaders & Goldin-Meadow, 2002; Goldin-Meadow, 2004, 2010).

Learning to manage levels of bodily tension during communication is an important requirement, as social and emotional factors that are part of communication also impact muscular tension and its regulation (Harbonnier-Topin & Ferri, 2011). This can be more complex for students whose disabilities involve high tone (Jones, Horn, & Warren, 1999), high levels of arousal or anxiety, or difficulties modulating behaviour across different social/communication settings (Renk, Lauer, Weaver, Scott, Middleton, & White, 2011). At the same time, studies have demonstrated the possibility of learning to regulate bodily tension (Olander & Bergentoft, 2013).

Physical disability can impact understanding of the world and restrict social interaction (Aro & Ahonen, 2011), in addition to affecting the communicative capacity of the body, hence, there is a need to support the learning and development of gestural communication and the physical aspects of social interaction. Classroom-relevant indicators in this area include regulating bodily tension, achieving successful gestural communication, and responding appropriately to others for cooperative sharing of space.

Performance sustainment. Bernstein (1996) considered strength, speed and endurance to be progressively more complex psychological capacities, involving cooperation among subsystems to achieve extended action goals and requiring abilities not only to supply sufficient energy for action, but to spend with a “tight, sensible frugality”, respecting limitations (p.11) – also learnable actions. The importance of considering the sustaining of physical engagement as a separate aspect is also supported by the emphasis on health in the ICF, the WHO’s estimation of 500 million life years lost due to ill health (WHO, 2001), and the need to support the development of an exercise lifestyle in children for whom physical

disability results in greater difficulty in moving and less opportunity for physical activity, leading to reduced fitness and lower motivation to physically engage (Jirikowic & Kerfeld, 2016; Maltais, Wiart, Fowler, Verschuren, & Damiano, 2014; Stout, 2012). As well, the ability to independently execute movement tasks supports causal agency and self-determination (Shogrun & Turnbull, 2006), generalised self-efficacy (Cairney, Hay, Faught, Wade, Cournia, & Flouris, 2005), and helps to prevent secondary disabilities of over-dependence and decreased motivation and self-esteem (Missiuna & Pollock, 1991).

Of the two facets of physical fitness – motor fitness related to athletic performance, and health-related fitness related to daily functioning, it is the latter that pertains particularly to the classroom, as it views any physical activity as reciprocally related to motor fitness, regardless of level of strenuous attainment (Stout, 2012). In students without physical disabilities, performance of classroom tasks generally does not require strenuous or sustained effort or the need to pace oneself, however, this is not the case for students with motor performance difficulties, who frequently require these skills in the execution of daily tasks (Munkholm et al., 2010). Not only does this make the extent of their capacities in these areas observable to the classroom teacher, but also able to be instructed and scaffolded in the classroom setting, utilising ordinary classroom tasks (O'Brien, 2015). This explains the presence of this aspect of movement in the School AMPS assessment – particularly in the motor skills 'Paces' and 'Endures', though the tasks being engaged upon are pen-and-pencil writing, drawing and colouring, cutting and pasting, computer writing, and math manipulative tasks (Fisher et al, 2007). Suggested indicators for this area include fulfilling strenuous movement requirements, persevering in difficult movement tasks, and regulating involvement within safe limits.

Chapter Summary

This chapter has reviewed the scholarly literature and empirical research on the construct of goal-directed movement. In exploring the possibility of establishing a learning progression enabling teachers and therapists to identify student progress through the domain, it has:

- described goal-directed movement positively and accessibly,
- considered its ‘vertical’ aspect – hypothesizing features of an acquisitional sequence, and
- reviewed its ‘horizontal’ aspect – proposing five classroom-relevant aspects and examples of some important, indicative skills.

Chapter Four will review occupational therapy motor skill assessments for teacher-use, current at the time of this investigation, for their effectiveness in directing teacher and therapist attention to starting points for learning, and outline a developmental learning approach to assessment that supports identification of learning readiness.

Chapter Four: Operationalising the Construct of Interest

The review of findings from Chapter Two suggested the importance of individualised approaches to successful student learning (Foreman, 2015; Griffin, Murray, Care, Thomas, & Perri, 2010; Smith, 2009; Tomlinson, 2005). To match instruction to individual need requires knowledge of the student's ZPD (Vygotsky, 1978) – where they are situated in the learning domain – established through formative assessments drawn from each area's underpinning learning progression, or theory of how learning proceeds (Black & Wiliam, 1998a, 1998b; Bloom et al., 1971; Griffin, 2007, 2018; Heritage, 2008; Maloney et al., 2014; Shepard, 2000, 2007; Tomlinson, 2014; Wilson, 2009). Chapter Two also suggested classroom-related goal-directed movement as an important cross-curricular learning area, or “general capability”, according to occupational therapy analyses of the broad motor requirements of learning, and the definition of General Capabilities in Australian and Victorian curricula – “processes of *physical*, personal, and social development and growth needed to meet the demands of the contemporary, globalised world” (DET Victoria, 2005b, p.1; see also Howes, 2012). However, at the time of this investigation, a learning progression and means for formative assessment of classroom-related goal-directed movement supporting generalist teachers to address this skill educationally was not found in educational or occupational therapy literature. Chapter Three then followed with a review and analysis of the construct of interest as a learning domain, according to recommendations that this consider both vertical (qualitative growth) and horizontal (aspects and skills) dimensions (Masters, 2013; Young & Tong, 2015).

The current chapter is in three parts. The first considers assessment principles relevant to judgement-based assessment. The second provides a critical review of measures in current use to evaluate classroom motor functioning, focusing particularly on judgement-based

assessments developed by occupational therapists for teachers to use. The third outlines an alternative approach and conceptual framework for judgement-based assessment design in education.

Assessment Principles

Purpose

In the Standards for Educational and Psychological Testing (AERA, APA, & NCME, 1999), the authoritative consensus statement about development and evaluation of educational and psychological tests, identification of purpose begins the process of assessment development (Linn, 2006). Through determining purpose, later decisions about item content, data collection methods, methods of scoring or coding, and means of establishing reliability and validity are supported.

Assessment that informs teaching has been defined as “the search for evidence of learning (Griffin, 2018, p.14). In occupational therapy, client-centred measurement seeks “a careful understanding of the individual” (Law & Baum, 2005, p.9) and a holistic grasp of the nature of occupational performance problems, establishing both the enablers and constraints of functioning. This requires a range of information-gathering strategies (McDowell, 2006; Missiuna & Pollock, 1995), from informal interviews and observations of task performance to formal assessments, for purposes of:

- discrimination – differentiating between typical and non-typical performance and providing problem descriptions and reasons for performance difficulties,
- prediction – classifying people into predefined categories, where these exist, to support determinations of need for further assessment, funding eligibility, and placement, and

- evaluation – measuring change over time, with a focus on evaluating the outcomes of intervention (Hanft, 1996; Kirshner & Guyatt, 1985; Missiuna, Rivard, & Bartlett, 2006).

An additional purpose of prescription has also been proposed – assessments that support clinical decision-making and direct therapy (Fisher, 1992). This last purpose bears most on this investigation’s goals.

The key purpose of assessment for teaching and/or learning purposes is to “advance student learning and enhance informed teaching intervention” (Pavlovic, Awwal, Griffin, & Alom, 2018, p.79; see also NSW Education Standards Authority [educationstandards.nsw.edu.au]; Queensland Curriculum and Assessment Authority [qcaa.qld.edu.au]; Victorian DET [education.vic.gov.au]). Within this purpose, two main roles for assessment are summative – measurement *of* learning, and formative, or diagnostic – measurement *for* learning (Heritage, 2008; Readman & Allen, 2013), both of which have been situated within a larger use of assessment as *for teaching* (Griffin, 2018). A variety of evidence-collecting strategies have also been utilised, which include performance- and judgement-based assessments that use rating scales (Engelhard, 2013; Ryan, 2006; Wiggins, 1998). Ideally, assessment for teaching and/or learning purposes should institute a teaching and intervention cycle – following formative and summative assessment student results are interpreted against the framework of the domain’s learning progression and a judgement about overall level of achievement made, after which differentiated instruction tailored to that learning level takes place (Griffin, 2007; Pellegrino et al., 2001). A *criterion-referenced* learning progression is at the heart of this assessment-for-teaching approach.

Norm- and Criterion-Referenced Assessment and Interpretation

In both educational and occupational therapy measurement practice, norm-referenced and criterion-referenced assessment strategies are recognised (Cohen, Hinojosa, & Kramer, 2010;

Glaser, 1963, 1981, 1994a; Popham, 2011; Richardson, 2015). Their fundamental difference is in the purpose to which results are put; however, assessment construction is also influenced. The purpose of norm-referenced assessment and interpretation is establishment of performance relative to typical others, while criterion-referencing seeks to ascertain the extent to which an *absolute* performance standard against pre-defined criteria has been achieved (Laver-Fawcett, 2007).

In education, assessments for norm-referenced interpretation seek to “maximise the discriminations” between subjects, without necessarily establishing exhaustively what is known or has been achieved (Glaser, 1963, p.520). Similarly, in occupational therapy, standardized, norm-referenced assessments fulfil discrimination and prediction purposes, measuring cross-sectional differences between people and classifying them by their alignment to, or deviation from, normed standards, without necessarily establishing the extent of this further (Fisher, 1992; Guyatt, Deyo, & Charlson, 1989; Kirshner & Guyatt, 1985; Ottenbacher & Cusick, 1993). Three standardized, norm-referenced occupational therapy motor skill assessments, recommended for use in Australian schools and previously reviewed in Chapter 3 are the *Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition (BOT-2)* (Bruininks and Bruininks, 2005), the *Movement Assessment Battery for Children, 2nd edition (Movement ABC-2)*, (Henderson et al., 2007), and the *Peabody Developmental Motor Scales, 2nd edition (PDMS-2)*, (Folio & Fewell, 2000) (Department of Education and Training Victoria, 2016; Independent Schools Victoria, 2014; Victorian Auditor-General’s Office, 2012).

At the same time, it has been noted that a practice of diagnosing and labelling deficits can become “mismeasurement”, through incorporating limits “imposed from without, but falsely identified as lying within” (Neisworth and Bagnato, 2004, p.198). In connection to school-based occupational therapy, therapist goals of problem-identification and disability screening

do not necessarily reflect teacher and classroom learning requirements (Coster et al., 1998; Kielhofner, 2006). As Glaser (1981) has stated, “tests can be used either to determine a level of development whose limits instruction should not exceed, or to assess levels of learning that might possibly be attained” (p.934). This latter, *formative* assessment purpose – “gathering evidence that can be used to draw conclusions about where students are in their long-term progress” (Masters, 2013, p.32; see also Forster, 2009; Pellegrino, 2002), is the information teachers require, which, as stated previously, requires an abilities-based, criterion-referenced approach and alignment of assessment to curriculum and instruction (Pellegrino et al., 2001). Importantly, in Glaser’s (1963) original conceptualization, criterion-referenced interpretation refers results to an underlying acquisitional continuum made up of “criterion-referenced measures of achievement or proficiency” (p.519), with the goal of establishing levels of learning along this developmental pathway (Masters, Adams, & Wilson, 1990). At key points, criteria denote a threshold to a new level has been reached, enabling interim student capacity to be interpreted positively as having reached that stage (Glaser, 1981; Griffin, Rickards, & Francis, 2018). Describing “regularities at different levels of development” can then guide instructional decisions (Glaser, 1981, p.923). The primary goal of criterion-referenced assessment to establish this correspondence between student performance and the underlying learning progression requires the progression, or theory of learning in the domain, to be known (Masters et al., 1990; Wilson, 2009).

In occupational therapy, criterion-referenced assessments aim to establish absolute (dichotomous pass/fail) competence to perform domain skills irrespective of the performance of others (Crocker & Algina, 1986; Griswold, 2010; Laver Fawcett, 2007; Richardson, 2015). While the domain area is the focus, the concern for a pass-fail result differs from Glaser’s (1963, 1981) conception with its underpinning learning progression and multiple levels of positively described learning attainment. Criterion-referenced occupational therapy

assessments have been described as detailed “developmental checklists” of skills (Richardson, p.170), focused on establishing dichotomous “master and non-master” status – a behaviourist approach to defining and assessing competencies (Crocker & Algina, 1986, p.193; Fisher & Jones, 2011; Laver Fawcett). Criterion-referencing in occupational therapy can thus be defined as more fine-grained, linear domain coverage to establish the mastery/non-mastery point in the continuum of skills. When the items are arranged hierarchically by relative difficulty, the point of performance break-down directs attention to work-around strategies and modifications to mitigate the impact of inability, and/ or to the next skill to learn (Coster, 2006; Fisher, 1992; Gibson et al., 2009; Velozo, Forsyth, & Kielhofner, 2006; Richardson).

In education, a dichotomous, linear approach was also adopted, following Glaser’s initial proposals; however, this resulted in a declining interest in criterion-referenced assessment because of the association with “long checklists of skills to be taught, assessed and checked off when mastered”, without evidence that this improved learning (Masters & Evans, 1986, pp.257-258; see also Griffin, 2007). In a reflection on his earlier work, Glaser (1981) noted that the concept of criterion-referencing had not been intended for this use, but to achieve indications of *learning* stage around which to design instruction – an additional, quality dimension of more central importance than the assessment itself (see also Pellegrino et al., 2001). Exhaustive checklists implied learning was essentially quantitative/arithmetic, rather than involving deepening capacity in a qualitative sense as a “chain of metamorphoses” supported by teaching intervention (Vygotsky, 1993, p.30).

The result of the checklist approach was referred to as “a deficit model of learning, (with) teachers focusing on what was lacking, or gaps in the list (while) relationships between items tended to be ignored and the notion of developmental learning was lost” (Griffin, 1997, p.13; see also Wolf, 1995). Glaser’s conceptualisation of learning, focused on the relationships

between items, supported a multiple levels conceptualisation. Standard setting formally describes this process.

Standard Setting

In education, assessment development includes establishing cut-scores that divide results into regions, or meaningful clusters of items with similar scale values that illustrate progress in the amount of the variable being exhibited, moving from less to more (AERA, APA, NCME, 1999; Cizek & Bunch, 2007; Lewis, Mitzel, Mercado, & Schulz, 2012). Each cluster is then provided with empirically-based performance level descriptions. Students may be dichotomously (pass or fail) or polytomously scored, and standard setting may likewise divide the scale. Establishment of pass-level competency requires only two score regions, whereas establishing learning progress requires multiple performance levels to be described (Eckes, 2012). The importance of this work comes from the need to guide the categorical decisions that judges make anyway, in a defensible and considered way (Cizek, 2006).

Within the standard setting process, scheduling of multiple, iterative decision-making occasions is preferable to a single event, as multiple rounds help to reduce judgement variance, allow for reconsideration of initial recommendations, and are experienced by participants as more democratic and fair (Jaeger, 1982; Kellow & Wilson, 2008).

Consequently, a common approach in standard setting is to convene a Delphi panel, which facilitates reasoned consensus among experts via anonymous, structured, multiphase processes, moderated by a referee who moves panellists towards consensus through feedback mechanisms (Dalkey, 1969; Gordon, 1994; Okoli & Pawlowski, 2004). Anonymity helps preserve diverse opinions and supports independent decision-making, which are important considerations for health professionals who tend towards conformity decision-making in face-to-face situations such as focus groups (Atwal & Caldwell, 2005; Mackey, 2006).

Additionally, systematically-achieved convergence of group opinion produces a more rational

outcome than the opinion of single experts (Hambleton, 2001; Jaeger). Consequently, an internet-based, asynchronous Delphi panel was selected for this multi-round standard-setting work by occupational therapists, over these other decision-making options.

Six aspects need to be considered when standard setting – 1) identification of purpose, 2) scheduling, 3) the use of qualified and well-informed participants, 4) the means of providing feedback to participants during the process, 5) establishing referents or descriptions of each performance level, and 6) evaluating the process (Cizek, 2006), relevant aspects of which will be discussed next, in turn.

Purpose. Out of four purposes for standard setting – exhortation, exemplification, accountability, and certification, particularly relevant for educators seeking to establish learning levels in non-academic areas are the former two. Exhortation establishes high expectations of learning capability for students that may otherwise have been deemed unable to learn, and exemplification describes each learning level by the competencies that positively exemplify it. Reporting formats must also align to purpose – particularly, the level of detail provided in reports must satisfy the purposes and match to the backgrounds of intended users (Stephanou, 2000). This may entail different reporting formats for different stakeholder groups (Brindley, 1998).

Scheduling. As an event, standard setting can be scheduled before or after an assessment has been conducted. In non-academic learning domains, the issue of fundamental fairness does not apply, hence standard setting can follow assessment administration and take advantage of dependable results. As already noted, scheduling of more than one decision-making occasion, or round, is recommended, hence the choice of a Delphi process that entails this (Dalkey, 1969; Gordon, 1994). In terms of recommended number of rounds, this varies in the Delphi literature, in consideration of the number and type of decisions to be made and the availability of panellists for extended work, however, in reviewing many studies, three

rounds are noted as sufficient for consensus in most cases (Hsu & Sandford, 2007; Keeney, Hasson, & McKenna, 2006; O'Donovan, Mohile, & Leech, 2015; Trevelyan & Robinson, 2015).

Participants. Standard setting participants need to be qualified to engage in the judgement task and to understand its requirements (ACME, APA, NCME, 1999).

Extent and homogeneity of participant qualification. Particularly important in relation to purposes of exhortation and exemplification is expertise in relation to motor learning and relearning for individuals with physical impairments. Delphi panel standard setting studies also stress the need for qualified panellists (Clayton, 1997; Green, Jones, Hughes, & Williams, 1999) and recommend inclusion and exclusion criteria for selection be decided beforehand (Keeney et al., 2006). Homogeneity of professional background and expertise, rather than more random samplings of professions, has been found useful for achieving requisite levels of group expertise in such work (Hung, Altschuld, & Lee, 2008; Keeney, Hasson, & McKenna, 2011). Panellist anonymity is a Delphi recommendation, as it supports maintained response rates, independent opinion, and consensus building (von der Gracht, 2012). As noted previously, where consensus work involves allied health professionals, anonymity is an important consideration, due to the levels of professional insecurity, reluctance to voice opinion, and tendencies towards a conformity-dominant culture which have been documented (Atwal & Caldwell, 2005; Mackey, 2006). More specifically, a lack of assertive confidence and a tendency to “fit in” with prevailing opinion has been noted in occupational therapy (Parker, 2001).

Participant number. While the Delphi literature does not recommend a certain number of participants for standard setting work, commenting that successful outcomes have been achieved in groups from 3 to 3000 participants (Hung et al., 2008; Keeney, Hasson, & McKenna, 2011), it has also noted that optimal size relates to degree of homogeneity – if

high, a small sample size is preferred, as very large homogenous groups reduce outcome accuracy (Rowe & Wright, 2001).

Feedback. Participant feedback during the standard setting process enhances useful and meaningful task accomplishment (Cizek & Bunch, 2007). In the multiple rounds of the Delphi method, participants receive feedback of different kinds between each round, including normative, retrospective feedback summarising group judgements, and prospective “feed-forward” – communicating extent of consensus reached to that point (Gordon, 1994, p.5; see also Kleynen et al., 2013).

Referents. Level descriptions created during the standard setting process distil and express the knowledge and skills of each learning level, serving to clearly delineate one level from the next (Lewis et al., 2012). This aligns well with Glaser’s (1981) conceptualisation of criterion-referencing, with its goal to understand skill clusters and describe their common themes.

Evaluation. Either an external or internal focus. In non-academic areas, reference to external standards do not apply, hence, internal considerations such as achievement of consensus provide a means for evaluating success. Regarding evaluations of consensus, the Delphi literature contains different understandings of when consensus can be claimed, while noting the importance of achieving convergence of opinion (Hsu & Sandford, 2007). In a decade of use of Delphi panels for standard setting, Keeney et al. (2006) concluded a statistical minimal level of 75% agreement was sufficient.

In occupational therapy assessment interpretation, at the time of this investigation elements of standard setting work had been undertaken for a small number of assessments, though Delphi processes had not been used. For example, expert practitioners had applied cut-off scores to instruments to establish safety to live independently (Fisher & Jones, 2011) and fitness to drive (VicRoads, 2017). Elsewhere in health, “functional staging” of outcome

measures had been attempted, cutting performance continua into hierarchically arranged profiles to achieve meaning beyond summary scores (Jette, Norweg, & Haley, 2008, p.963; Marfeo, Ni, Chan, Rasch, McDonough, Brandt, Bogusz, & Jette, 2015; Okochi, Takamuku, & Escorpizo, 2013; Sinha, Slavin, Kisala, Ni, Tulskey, & Jette, 2015; Stineman, Ross, Fiedler, Granger, & Maislin, 2003; Tao, Haley, Coster, Ni, & Jette, 2008; Woodbury, Velozo, Richards, & Duncan, 2013; Woytowicz, Rietschel, Goodman, Conroy, Sorkin, Whittall, & Waller, 2017). Table 9 compares the main features of these attempts.

Table 9 *Standard Setting of Health Measures*

Study	Construct assessed	Cut-point criteria	No. levels	Content of level descriptions	Norm- or criterion-referenced goal
Fisher & Jones, 2011	Motor/ process ability for independence	Task aspects, assistance needs	3	Broad, general	Norm-referenced (i.e., independent functioning)
Jette et al., 2008	Mobility	Environmental aspects	5	Broad, general	Norm-referenced (i.e., independent movement in standard environments)
Marfeo et al., 2015	Physical daily task performance	Task aspects	5	Broad, general	Norm-referenced (i.e., standard performance of everyday tasks)
Okochi et al., 2013	Transferring and maintaining bodily position	Bodily aspects	5	Specific (progression of skills by difficulty)	Criterion-referenced (highest level – achieves and maintains standing)
Sinha et al., 2015	Upper body functioning	Task aspects	4	Broad, general	Norm-referenced (i.e., standard hand and upper limb functioning)
Stineman et al., 2003	Independent in daily activities	Task aspects	7	Specific (progression of ADL tasks by difficulty)	Norm-referenced (i.e., independence in all ADL, including bathing)
VicRoads, 2017	Driving ability	Task aspects	6	Specific (positive inputs to build capacity)	Norm-referenced (i.e. safe, independent driving)
Woodbury et al., 2013	Specific upper extremity movements	Bodily aspects	3	Specific (progression of movements by difficulty)	Criterion-referenced (highest level – achieves 26 of 30 possible movements)
Woytowicz et al., 2017	Physical movement	Bodily aspects	4	Broad, general	Criterion-referenced (highest level – performs without synergistic movement)

Outcome measures monitor the effectiveness of interventions rather than guide them (Haley et al., 2003). Consistent with this purpose, an interest in supporting summative judgements and recovery predictions is apparent in this staging work (Jette et al., 2008; Sinha et al., 2015; Woodbury et al., 2013; Woytowicz et al., 2017), also a norm-referenced lens, with typical functioning being perceived as the pinnacle (e.g., ‘independent’ – Fisher & Jones, 2011; Stineman et al., 2003; ‘able’ – Jette et al., 2008; ‘fit to drive’ – VicRoads, 2017; ‘normal’ – Woodbury et al., 2013). The broad generality and outcome purpose of the level descriptions do not support evaluations of learning readiness; however, in some cases a future intervention focus is indicated by the specific skills or provisions of the next stage (Okochi et al., 2013; Stineman et al.; VicRoads; Woodbury et al.). Overall, the work of standard setting in health has a retrospective orientation and function – establishing the outcomes of intervention at its close, though the potential to guide therapy throughout intervention has also been recognised (Woodbury et al., 2013). At the time of this investigation, standard setting of judgement-based occupational therapy measures designed for proxy teacher administration was not found.

Judgement-based Assessment

An occupational therapy concern for an alternative to the deficit-oriented medical model has moved measurement interest from traditional “bottom-up” assessments of task components to “top-down” judgement-based assessments of whole tasks in their natural settings (Trombly, 1993, p.253; see also AOTA, 2014; Chien & Brown, 2017; Coster, 2008; Coster, Haley, Andres, Ludlow, Bond, & Ni, 2004; Doucet & Gutman, 2013; Fisher & Short-DeGraff, 1993; Weinstock-Zlotnick & Hinojosa, 2004). In school settings, such in-context assessments are developed mainly for proxy teacher administration, which also supports their “ecological validity”, as the impacts of environment and natural task are incorporated; hence, generalisation to actual settings post-assessment is not required (Engelhard, 2013, p.319).

Indirect, judgement-based teacher questionnaires do not involve assessment tasks and test situations as they work from existing teacher knowledge. As noted in Chapter Two, the ability of teachers to accurately judge student performance has been recognised (Larkin & Rose, 2005, Meisels, DiPrima Bickel, Nicholson, Xue, & Atkins-Burnett, 2001; Missiuna & Pollock, 1995; Netelenbos, 2005; Rubie-Davies et al., 2007; Shapiro, 2003; Winne & Perry, 2000); however, concerns have also been expressed about their competency in relation to constructs outside their domain of expertise (Faight et al., 2008; Junaid et al., 2000; Schoemaker, Niemeijer, Flapper, & Smits-Engelsman, 2012). This directs attention to the rating scales assessment designers have provided for scoring, for their support of teacher interpretive judgement.

Rating Scales

The use of rating scales with multiple response options of Likert- or frequency type is common to judgement-based questionnaires (Alphen, Halfens, Hasman, & Imbos, 1994; Embretson & Reise, 2000; Engelhard, 2013; Laver Fawcett, 2007; McDowell, 2006). Such rating scales have commonly been based on the weak assumptions of classical test theory (CTT), that items are parallel instruments for measuring constructs, that there is a simple connection between data and reality, and that summing results is sufficient to estimate relative standing (Hambleton & Jones, 1993). Deficit-oriented rating scales have lower level response options that mainly express degrees of inability, with positive achievement – in most cases typical, able-bodied ability - kept for the final level. Dichotomous scoring is possible with such scales – combining the lower levels as ‘not achieved’. This supports establishment of performance against local standards or age/norm expectations (Coster & Frolek Clark, 2013). Examples of such scales in therapist-administered assessments include:

- School AMPS’ 4-point metric (Fisher et al., 2007) (1=severely deficient; 2=ineffective; 3=questionable; and 4=readily and consistently achieves),

- Melbourne Assessment of Unilateral Upper Limb Function's 4-point metric (Bourke-Taylor, 2003) (e.g., *Sub-skill 3(testing movement fluency) – Reach for an object*: 0=unable; 1=clearly noticeable jerkiness or tremor; 2=barely noticeable jerkiness or tremor; 3=smoothly coordinated movement),
- Pediatric Balance Scale's 5-point metric (Franjoine, Gunther, & Taylor, 2003) (e.g., *Q12 – Pick up eraser placed on the floor in front of feet*: 0=unable to try, needs assistance to keep from losing balance or falling; 1=unable to pick up eraser, needs supervision (spotting) while attempting; 2=unable to pick up eraser but reaches 1-2 inches from eraser and keeps balance independently; 3=able to pick up eraser but needs supervision (spotting); 4=able to pick up eraser safely and easily),
- Preschool Imitation and Praxis Scale's 5-point metric (Vanuchelen, Roeyers, and De Weerd, 2011) (e.g., *Q13 – Pretend to comb your hair with an imaginary comb*: 0=performed another action or refused to imitate; 1=used body-part-as-object grip and performed repetitive action on one side of head or single action; 2=used body-part-as-object grip and performed repetitive action on both sides of head; 3=used symbolic grip and performed repetitive action on one side of head or single action; 4=used symbolic grip and performed repetitive action on both sides of head), and
- Miller Function and Participation Scales' 4-point metric (Miller, 2006) (1=a lot like the less competent child, 2=a little like the less competent child, 3=a little like the competent child, and 4=a lot like the competent child).

Both the design of judgement-based assessments and their rating scales and coding procedures impact on results (Kane, Crooks, & Cohen, 1999; Rudner, 1994). Assessor judgement is made difficult by broad, generic rating criteria, and usefulness to teaching is

impacted by a deficit orientation (Engelhard, 2013; Griffin, 2007; Griffin et al., 2004; Johnson, Penny, & Gordon, 2009). This raises questions of educational and clinical utility (Smart, 2006) and assessment methodological quality – the reliability and validity of assessments and results.

Methodological Quality

Reliability

An assessment's reliability, or generalisability, refers to its ability to produce a consistent, repeatable outcome for test-takers at the same level of competence across different times and places (Crist, 2014; Engelhard, 2013; Gillis & Bateman, 1999; Kane, 2013; Thorndike, Cunningham, Thorndike, & Hagen, 1991). A repeatable outcome indicates consistent measurement of the trait of interest; hence the assessment can be deemed a reliable instrument for measuring that trait, and the person's score a trustworthy indication of their ability. Establishing test reliability is foundational to classical test theory (CTT) (Lord, 1952; Wu, Tam, & Jen., 2016), which assumes that a person's actual test score (X) is made up of their ability or true score (T) combined with other unwanted influences on their performance, which introduce error (E). Mathematically, this is expressed as $X = T + E$. The calculation of the standard deviation of the errors (standard error of measurement [SEM]) subtracted from the observed score, expressed as a ratio, produces the statistical reliability, or correlation co-efficient, of the test – its *internal consistency*, or measure of true score approximation (Cronbach, 1951). This is expressed as an index between 0 and 1, where closeness to 1 indicates high likelihood that results will be similar on repeat testing, hence, high test reliability.

Minimisation of errors brought about by assessment design is an important goal in assessment development (Wilson, 2005). One source of error in judgement-based questionnaires that utilise a rating scale is that these do not support reliable, consistent

judgement. Rating scales must have “sufficient detail and clarity to maximize the accuracy of scoring” (AERA, APA, & NCME, 1999, p.47; Linn, 2006). Broad, generic rating scales, with descriptions that require considerable interpretation, result in subjective “holistic” judgements with considerable error margins (Clauser, 2000, p.313; see also McDowell, 2006; Norcini et al., 1990). At the same time, analytical rating scales, containing greater objective specificity, can impact validity due to a tendency to focus on easily quantifiable over salient aspects (Clauser; Hamp-Lyons, 1995).

Validity

“Neither an assessment procedure nor an assessment score is valid or invalid in itself. It is only when an interpretation is assigned to the scores that the question of validity arises” (Kane et al., 1999, p.6; see also AERA, APA, & NCME, 1999; Messick, 1989; Velozo et al., 2006). Validity pertains not only to the extent to which assessment criteria measured the target construct (Crist, 2014), but the plausibility of interpretations of performance and the use of these conclusion in relation to the assessment’s stated purposes (Kane, 2013; Wu et al., 2016). Messick (1989, 1995) has proposed a unitary notion of validity that includes subsuming content and criterion-related validity under construct validity, emphasizing the importance of considering consequences of assessment, and considering multiple types of validity to achieve an overall judgement. Validity arguments must therefore gather evidence from a range of sources, including assessment content and response rating/coding scales, internal structure, relations to other variables (also called concurrent validity – an aspect of criterion-related validity), and consequences of interpretations of performance, to determine if and to what extent assessment purposes were achieved (AERA, APA, NCME; Downing, 2003; Wilson, 2005). Validity considerations relevant to this investigation include:

- Content validity, which is tied to test development (Kane, 2006), and considers construct definition, the items chosen to represent it, the extent to which these

sufficiently and representatively sampled the “universe of generalisation” (Kane et al. 1999, p.8), and the domain relevance of the strategy/ies selected to judge and code responses – the latter also termed response processes validity (Downing, 2003).

- Internal structure validity, which considers the extent to which the construct is conceived as having a certain order or development, the items sampling this span ensure sufficient evidence is collected to make a judgement, and results are unaffected by non-related factors (Gillis & Bateman, 1999; Wu et al., 2016).
- Validity in relation to other variables (criterion-related validity – concurrent and discriminant validity being aspects), which considers extent of coherence between assessment results and other known relevant factors, such as, for health- and disability-related areas, clinical diagnoses and indicators of impairment severity and functional impact. The concern here is establishing whether assumptions of correlation between different constructs, or lack thereof, are confirmed.
- Predictive validity, which considers the extent to which assessment results support accurate predictions of future performance and transfer of skill outside the test situation (Gillis & Bateman, 1999).
- Consequential validity, which considers the outcomes of assessment use, stressing the importance of these being positive (Messick, 1995; Wilson, 2005).

A strong, theoretical model is required to achieve validity according to these stringent conditions; hence, in health, assessments constructed from the relatively simple assumptions of CTT are being increasingly replaced by new measures constructed according to item response theory (IRT) (Belvedere & Morton, 2010; Reeve, Hays, & Chang, 2007; Tesio, 2003; Velozo et al., 2006; Wilson, Allen, & Li, 2006). IRT ensures assessment criteria cohere to an underlying construct and results achieve interval-level scaling (Clauser, 2000;

Downing, 2003; Embretson & Reise, 2000; Lord, 1952; Lord & Novick, 1968; Rasch, 1960, 1980; Wu et al., 2016).

Item Response Theory

Item response theory, also known as latent trait theory and the scaling tradition, was developed to measure student educational *achievement* rather than simply to establish test score (Engelhard, 2013; Lord & Novick, 1968; Rasch, 1960, 1980). This goal required the underlying unidimensional construct to be explicated progressively and sufficiently comprehensively to allow location of students along it – the “‘sine qua non’ for objective measurement” (Engelhard, 2013, p.177; Lord and Wright, 2010). In particular, the Rasch (1960, 1980) family of IRT models achieved “specific objectivity”, or separability of items and persons – item difficulty interpreted separately to student ability, and student ability to item difficulty (Wu et al., 2016, p.111; see also Pellegrino et al., 2001). These included the Rasch Model (Dichotomous Case) (Rasch, 1960, 1980), the Rating Scale Model (Andrich, 1978) for analysing polytomous rating scale data with step thresholds of fixed difficulty, and the Partial Credit Model (Masters, 1982) for analysing polytomous rating scale data with step thresholds that vary in difficulty.

Rasch (1960, 1980) theorised that a person’s performance on dichotomously-scored items was sufficiently explained by the amount of the assessed trait they possessed and the amount the item required. Mathematically, item difficulty was calculated as the ability of people whose chances of achieving that item had reached 0.5% probability. The result was joint calibration of people by ability and items by difficulty onto a common, interval-level scale, marked out by difficulty measures called logits, or “log of odds units” (Wu et al., 2016, p.110). A depiction of this histogram, called a Wright map (Wilson, 2005) for illustrating dichotomous case items, placed each item on the map once, at the point aligned to students who had 50% chance of achieving it. This map has been extended for items containing

partial-credit steps of increasing difficulty (Masters, 1982), where each step represents a threshold to a new learning level – for this investigation, called an *item-threshold map*. A generic example of this is provided at Figure 8. Students, represented by X's on the left, are placed according to their assessed ability along the vertical logit scale, with its mean set to 0, and also against those *item-thresholds*, on the right, they have 50% probability of achieving. Item-thresholds below that point they have relatively more chance of achieving, and those above them, less. Item 1 has been shown in *italics* to illustrate its step difficulty increase across the scale. The map illustrates that it is the *threshold difficulties* or *steps* of the items that are ordered, not the items.

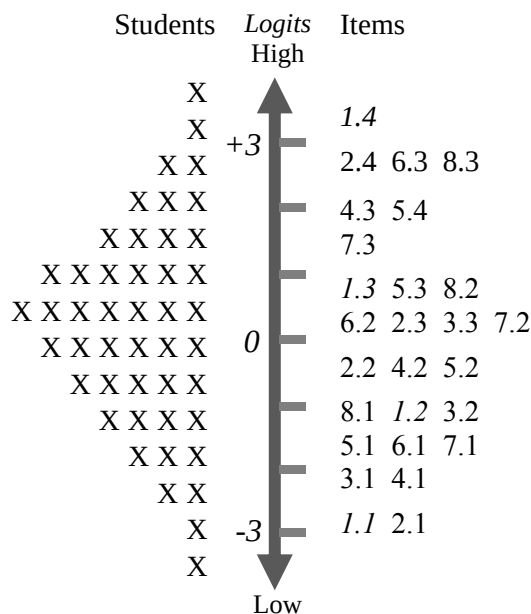


Figure 8. A generic item-threshold map (Griffin, 2009, p.193)

For educational purposes, explication of the latent trait in this way assists identification of skills that students are just beginning to acquire, where achievement likelihood has reached 50%. As explained in the discussion of differentiation presented in Chapter Two, according to the Vygotskian (1978) notion of the ZPD, this is the optimal zone for instructional intervention.

This concludes the first section of the chapter, discussing principles of assessment construction and analysis. The next section reviews a set of assessments developed by occupational therapists for proxy teacher administration. While occupational therapy assessments are now increasingly constructed according to IRT, all but one of the instruments discussed next were developed within the theoretical framework of CTT.

Review of Judgement-based Instruments for Teacher Administration

This section reviews instruments developed by occupational therapists for teacher administration to measure the construct under study – classroom-based, goal-directed movement. While there has been growing commitment to obtaining child and parent perspectives on the impact of motor functioning on participation and independence (Costa & Lindenthall, 2015; Dunford et al., 2005; Missiuna et al., 2006; Wilson et al., 2000), the focus of this investigation to evaluate teacher-use instruments derives from the concern to improve teacher ability to identify motor learning needs and to support and guide their instructional planning; hence, teacher-administered and judged instruments are the focus of this review.

Selection Process and Criteria

An initial electronic search of the Cumulative Index to Nursing and Allied Health Literature (CINAHL) database was conducted, for information and reviews of motor skill assessments in current use by paediatric occupational therapists in school-settings. CINAHL is the most comprehensive index of occupational therapy journals, including those from America, Australia, Britain, and Canada with the highest journal rankings. In addition, the highly relevant *Journal of Occupational Therapy, Schools, & Early Intervention* was searched, as well as major reference works in paediatric physical rehabilitation (Campbell, Palisano, & Orlin, 2014; Case-Smith & O'Brien, 2014; Effgen, 2013). The criteria that guided selection was:

- judgement-based assessments for proxy teacher-administration,

- concerning classroom-related movement performance in natural classroom settings,
- pertaining to children aged 4 to 18 years,
- in English, and
- with development and administration details accessible to the researcher.

Excluding the large list of standardised, norm-referenced assessments developed for therapist administration, seven judgement-based instruments for teacher administration were identified:

1. Children Activity Scales – Teacher version (ChAS-T) (Rosenblum, 2006).
2. Handwriting Proficiency Screening Questionnaire (HPSQ) (Rosenblum, 2008).
3. Motor Observation Questionnaire for Teachers (MOQ-T) (Shoemaker, 2003; Schoemaker et al., 2008)
4. Motor Skills Rating Scale (MSRS) (Cameron, Chen, Blodgett, Cottone, Mashburn, Brock, & Grissmer, 2012).
5. Movement Assessment Battery for Children-2 Checklist (MABC-2 Checklist) (Henderson et al., 2007).
6. School Function Assessment (SFA) (Coster et al., 1998).
7. Teacher Estimation of Activity Form (TEAF) (Faught et al., 2008; Hay & Donnelly, 1996).

These seven instruments were selected for review. A list of excluded instruments, with explanation for their exclusion, can be found in Appendix B. In the next section, the properties of the seven selected instruments are described against the conventional evaluation considerations of: a) theoretical orientation, b) practical considerations, c) psychometric qualities, and d) clinical utility (Bagner, Harwood, & Eyberg, 2006; Groth-Marnet, 2009; Smart, 2006). Educational utility is then considered as part of a combined final review.

Instrument Description

Children Activity Scales – Teacher version (ChAS-T)

Theoretical basis: The ChAS-T (Rosenblum, 2006) was developed as a screening tool for identification of children at risk for Developmental Coordination Disorder (DCD). Sources for item development were the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV)* (APA, 1994), other DCD screening questionnaires (Henderson & Sugden, 1992; Wilson et al., 2000), other literature current at the time of development, and interviews with ten parents about their children's functioning. Information regarding its theoretical basis is not readily available.

Practical considerations: The target age group is children aged 4-8 years. 21 items make up the teacher version of the ChAS-T – five items evaluating fine-motor performance, six items gross-motor performance, and nine items considering organisation of self in space and time. Teachers are directed to compare the student's performance with typical age-equivalent peers and provided with a 5-point Likert scale to support their judgement (1 = less adequately, 5 = very well). Time to complete is estimated at 5-10 minutes. No prior training is required.

Psychometric qualities: The ChAS-T was standardised on a sample of 355 children considered to be at risk for DCD. Cronbach's coefficient alpha of 0.96 indicated excellent item internal consistency, and item-total correlations were moderate to high. Factor analysis confirmed three principle factors with medium to high item loadings. Construct validity was established through comparison with student scores on the well-regarded MABC (Henderson & Sugden, 1992). The ChAS-T identified 67% of the same students as likely to have DCD – a moderate degree of agreement.

Clinical utility: The ChAS-T provides teacher support for the possibility that a student has DCD. Improved insight into student difficulties has also been proposed as an outcome of use (Rosenblum, 2006).

Movement Assessment Battery for Children – Checklist (MABC-Checklist)

Theoretical basis: The MABC-Checklist (Henderson et al., 2007) was developed as a criterion-referenced questionnaire with levels of difficulty, whose purpose was to economically screen for DCD, given that formal motor tests were “too time consuming” and “too expensive” for school screening purposes (Schoemaker et al., 2003, p.426). Its difficulty levels were developed from the theoretical framework of Gentile and colleagues (Gentile, Higgins, Miller, & Rosen, 1975).

Practical considerations: The target age group is children aged 4-12 years. The Checklist contains 30 items. It is divided into two sections, each further divided into three parts, wherein are five items each. The sections concern movement in static and dynamic environments and the parts consider self-care, classroom/ball skills, and PE skills. Teachers are provided with a 4-point Likert scale to record their judgements (0 = very well, 1 = just OK, 2 = almost, 3 = not close). Time to complete is estimated at 10 minutes. No prior training is required.

Psychometric qualities: The MABC-Checklist was standardised on a sample of 184 children – 120 randomly selected from mainstream schools, and 64 known to have motor functioning difficulties. Reliability in terms of homogeneity of items was calculated using Cronbach’s alpha, which was high at 0.96 (Schoemaker et al., 2003). Construct validity considered factor structure and identified seven factors as explaining 73% of variance (ball skills, static balance/rhythm, dynamic balance, fine manipulation, avoiding obstacles, body scheme/locomotion, and self-care). Discriminant validity was established by a comparison between known groups – a statistically significant score difference was achieved, and concurrent validity was established by results comparison with the MABC-Test, which also yielded correlations of statistical significance, but only for the six-year-old group.

Clinical utility: The MABC-Checklist supports pre-screening for DCD; however, the lack of sufficient concurrent validity with the MABC-Test and overall poor sensitivity indicates it cannot achieve this goal when it is the only test used (Junaaid et al., 2000; Wright & Sugden, 1996).

Motor Observation Questionnaire for Teachers (MOQ-T)

Theoretical basis: The MOQ-T (Shoemaker, 2003; Schoemaker et al., 2008) was originally developed in the Netherlands as the Groninger Motor Observation Scale to screen for DCD. It was developed in response to time-consuming standardized motor tests and the mixed psychometric property results of the MABC-Checklist. As a questionnaire, it fits with ecological recommendations for naturalistic observation of actual performance in real settings and not only standardized, clinical testing of capacity (Schoemaker et al., 2008). Information regarding its theoretical basis is not readily available.

Practical considerations: The target age group is children aged 5-11 years. The MOQ-T consists of 18 items, covering fine and gross motor functioning. Teachers are provided with a 4-point Likert scale to record their judgements (1 = never true; 4 = always true). Time to complete is estimated at 10 minutes. No prior training is required.

Psychometric qualities: The MOQ-T was standardised on a sample of 182 children – 91 with known motor problems and 91 randomly selected from a large population-based sample (Schoemaker et al., 2008). Discriminant and concurrent validity were evaluated as satisfactory (62% of children identified as likely to have DCD by the MABC-Test were also identified by the MOQ-T), and a factor analysis confirmed two factors – general motor functioning and handwriting.

Clinical utility: The MOQ-T supports clinical judgement about presence of DCD; however, as only preliminary work establishing validity and reliability has been undertaken, caution about results has been recommended (Rivard, Missiuna, Pollock, & David, 2012).

Teacher Estimation of Activity Form (TEAF)

Theoretical basis: The TEAF (Faught et al., 2008; Hay & Donnelly, 1996), originally a population-based assessment of physical activity and ability, has a goal of screening for motor coordination challenges and DCD. It focuses on self-efficacy, aptitude, and enjoyment of physical activity. Information regarding its theoretical basis is not readily available.

Practical considerations: The target age group is children aged 9-11 years. The TEAF is a 10-item scale, with six items concerning performance in school settings outside the classroom, including PE, and four relating to the classroom. Teachers are provided with a 5-point Likert scale for recording responses (well below average/ much worse, to well above average/ much better), which involves rating children against others of same-age and gender. Time to complete is estimated at 10 minutes. No training is required, though teachers need knowledge of student physical ability outside the classroom and in PE in order to complete all questions.

Psychometric properties: The TEAF was standardised on a sample of 502 children without physical diagnoses but considered to have probable DCD. Cronbach's alpha (0.98) and a factor analysis were used to establish instrument reliability and internal consistency. Teacher accuracy in judging was considered high and there was no gender bias evidenced (Faught et al., 2008). Convergent validity was reasonable in a correlation with aerobic fitness and results of a standardized test of motor proficiency and presence of DCD, the BOT-2 (Crawford, Wilson, & Dewey, 2001).

Clinical utility: The TEAF is adequate as a population-based preliminary screening for DCD and permits teachers to communicate their general perceptions of student physical ability in a structured way. As the performance of several individual items accorded with the full scale, it has been suggested the instrument could be shortened further without loss of discrimination capacity, supporting greater utility with busy teachers (Faught et al., 2008).

Handwriting Proficiency Screening Questionnaire (HPSQ)

Theoretical basis: The HPSQ (Rosenblum, 2008) is a teacher questionnaire supporting identification of handwriting difficulties in school-aged children. It was developed in recognition of the need for more standardized assessments in this area, and more structured communication between teachers and therapists to improve teacher judgement of difficulties (Sudsawad, Trombly, Henderson, & Tickle-Degnen, 2001) and team-based intervention decision-making (Hammerschmidt & Sudsawad, 2004). Information regarding its theoretical basis is not readily available.

Practical considerations: The target age group is children aged 7-14 years. The HPSQ consists of 10 items enabling handwriting deficiency to be indicated, in the aspects of legibility (3 items), performance time (3 items), and physical and emotional well-being (4 items). Teachers are provided with a 5-point Likert scale to support their observation of student handwriting during regular class activities (0 = never, 4 = always). Time to complete is estimated at 10 minutes. No prior training is required.

Psychometric qualities: The HPSQ was standardised on a sample of 230 children with no documented impairments or delays. Internal consistency, reliability (inter-rater and test-retest) and concurrent and construct validity were evaluated. Cronbach's alpha was 0.90, and the questionnaire was established as having good content and construct validity, moderate concurrent validity from comparison with two standardised handwriting instruments, and very good inter-rater and test-retest reliability (Rosenblum, 2008; Schwellnus et al., 2012).

Clinical utility: The HPSQ is considered a useful tool, both for screening for handwriting difficulties that are considered important to teachers and providing a means for discussing with students their perspectives on their handwriting status (Rosenblum, 2008).

Motor Skills Rating Scale (MSRS)

Theoretical basis: The MSRS (Cameron, Chen, et al., 2012) has a goal of providing a brief, cost-effective way for teachers to establish extent of relationship between academic and particularly maths difficulty and fine motor difficulty in early primary (elementary) students. It was developed in consideration of the cognitive processes that underlie motor performance. The authors note a “lack of underlying theory” in its development (p.563).

Practical considerations: The target age group is children aged 4-7 years. The MSRS consists of 19 items grouped into three aspects that have been established by factor analysis: a) shapes and letters, b) classroom fine motor, and c) body awareness. Teachers are provided with a 4-point Likert scale to support their judgements (1 = not at all, 4 = very much). Estimated time to complete is not provided. No prior training is required.

Psychometric properties: The MSRS was standardised on a sample of 242 typically developing primary (elementary) school students from two diverse sites. The items performed variously, partly, it was thought, because of their negative wording, and partly because they drew on underlying theoretical understandings that teachers may not have (Cameron, Chen, et al., 2012). Concurrent validity compared results with mathematics achievement and found these to be strongly positively correlated – underlining the important use of hands in learning maths. A follow-up study (Kim et al., 2014) confirmed the association of fine-motor skills with academic outcomes, and body awareness skills with sociality.

Clinical utility: The MSRS has a confirmatory function rather than an intervention focus. The findings indicate the value of using teachers to report on classroom fine-motor capacity and the need for early screening to initiate motor skill development for academic success.

School Function Assessment (SFA)

Theoretical basis: The SFA (Coster et al., 1998) is a criterion-referenced, judgement-based, “occupation-centred” assessment of the participation of students with physical and/or sensory impairments in school-related activities (p.337). It can be completed by any teachers, classroom aides, or therapists who know the student well. A “model of function” and a “disablement process” model underlies its design, (Coster, p.4), the latter derived from Nagi’s (1964, 1965, 1991) Disablement Model, which proposes function as a complex construct, definable at multiple levels of specificity and the measurement of disablement as ascertaining the impact of context on performance (Jette, 2009).

Practical considerations: The target age group is children 5-12 years. As a comprehensive instrument assessing all major areas of school functioning, the SFA contains, in its Activity Performance section, 18 Performance Scales, each with between 9 and 28 items – a total of 266 items. A 4-point continuous rating scale is provided for scoring (1 = does not/cannot perform, 4 = consistent performance to time and level expected). Time to complete is estimated at 1.5-2 hours. No prior training is required but familiarisation with the manual.

Psychometric properties: The SFA was standardised on a sample of 681 students with and without disabilities. High internal consistency for each of the scales was established (coefficient alpha 0.92 to 0.98) (Coster et al., 1998). However, while a later study largely confirmed the item-difficulty hierarchies, it noted significant misfit in 14 items, resulting in 3 scales failing to meet the criterion for unidimensionality (Hwang & Davies, 2009). Initial test-retest reliability established consistency of scoring over two occasions, with reliability coefficients between 0.82 and 0.98, though inter-rater reliability was not attempted (Coster et al., 1998). Factor analysis identified two moderately correlated factors – cognitive/behavioural function and physical function (Coster, Mancini, & Ludlow, 1999).

Clinical utility: As the only instrument of these seven reviewed that was developed using a Rasch (1960, 1980) measurement model, the SFA supports a purpose of identifying position of students within an absolute skill hierarchy, which aids intervention planning. In addition, “criterion cut off scores” enable norm-referenced comparison to same age neurotypical peers, informing funding/ placement decisions (Coster et al., 1998, p.667; see also Strein & Kuhn-McKearin, 2013).

Table 10 summarises the extent of information provided about these assessments.

Table 10 *Features of the Seven Reviewed Judgement-based Questionnaires*

Criteria	Assessments:						
	ChAS-T	MABC-C	MOQ-T	TEAF	HPSQ	MSRS	SFA
<i>Theoretical basis</i>							
Established	×	?	×	×	×	×	✓
<i>Practical considerations</i>							
Target group defined	✓	✓	✓	✓	✓	✓	✓
Ease of use	✓	✓	✓	✓	✓	✓	✓
Time	✓	✓	✓	✓	✓	?	✓
Training	✓	✓	✓	?	✓	✓	✓
<i>Psychometric properties</i>							
Reliability	✓	✓	?	✓	✓	?	✓
Validity	✓	?	?	?	✓	✓	✓
<i>Clinical utility</i>							
Screening	✓	?	?	✓	✓	✓	✓
Communication (teacher > therapist)	✓	×	×	✓	✓	?	✓
Intervention	×	×	×	×	?	×	✓

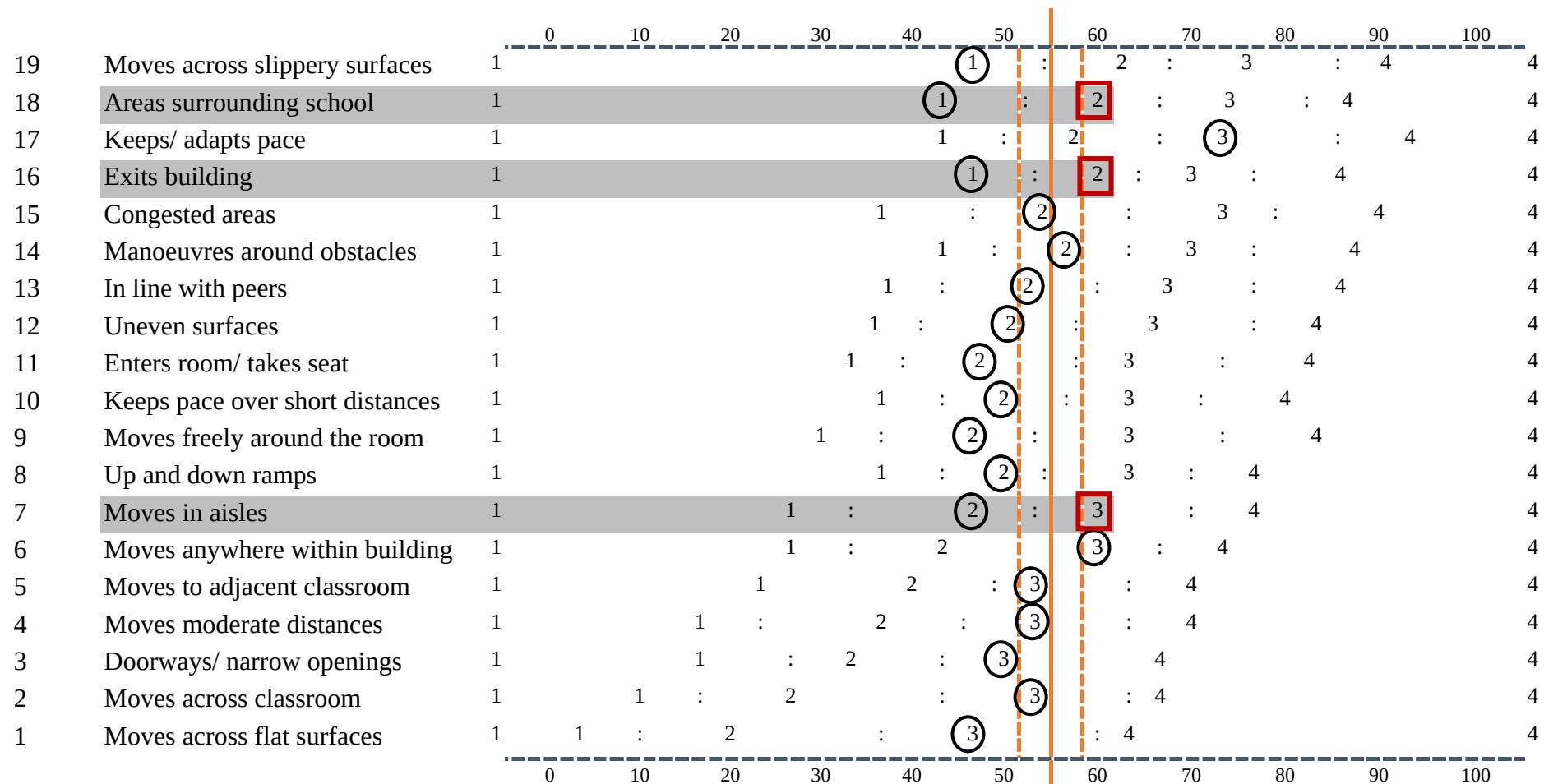
Notes: ✓ Criteria information is present with evidence
 ? Criteria information is present with limited evidence or requires further analysis
 × Criteria is not present/ mentioned

Overall Instrument Evaluation

Items. An overall concern with these questionnaires is their weak theoretical assumptions, consistent with the use of CTT for their development (Hambleton & Jones, 1993), apart from the SFA. As noted in the *Handbook of Test Development* (Lane, Raymond, & Haladyna, 2015), developing an assessment supportive of valid interpretations requires a systematic approach, an evidence-based domain definition and theoretical grounding for item design and domain representation (Lane, Raymond, Haladyna, & Downing, 2015). It is possible such background work was not deemed necessary in the case of the first four assessments addressed here (ChAS-T, MABC-Checklist, MOQ-T, TEAF), as the goals were ‘low-stakes’ preliminary screening tools for DCD, requiring a quick and structured way for non-movement specialists to communicate their general concerns (Faught et al., 2008). However, in the case of many of their items, the presence of ambiguous and subjective elements, such as counts and pseudo-counts (“takes a long time” “fills up page easily”), comparative terms (“gently”, “attractive”), and negative wording (“struggles”, “is rough”, “has difficulty”, “poorer than peers”) is a concern. These do not support judgement accuracy, and potentially elicit bias. Messick (1995) has stressed the need for justified interpretations of people based on their scores, which are difficult to attain when item descriptions are ambiguous or value-laden. Is an assessment of ‘attractive’ handwriting a measure of fine motor skill or assessor taste? Does a student who ‘does not excel at drawing’ necessarily lack fine motor skill? Griffin, Francis, & Robertson (2018) have noted the need for assessments to make “unequivocal inferences” about student capacity (p. 127). To achieve this, items must elicit evidence of skill and control for noise.

The extensive number of items in the SFA is a further concern. While the detail is consistent with an occupational therapy presentation of criterion-referencing (Richardson, 2015), the resulting checklist approach to intervention, according to an educational critique,

does not help to foster deep learning (Glaser, 1981; Griffin, 1997, 2007). The SFA Manual (Coster et al., 1998) illustrates this approach. A student scored on the 19 items of the SFA's 'Travel' scale first receives a converted (0-100) score representing their 'average' performance, which is marked on the corresponding "item map" by a line (p.37). These maps depict the order of item difficulty as well as the difficulty estimates of all the rating scale points of the items according to their non-uniform calibration by the Rasch partial credit model (Masters, 1982). In orientation, they present the 'horizontal' and 'vertical' dimensions in reverse to their presentation by Rasch IRT item-threshold maps, but consistent with the checklist approach that remains focused on the items of the assessment, as the rating scale descriptors do not contain learning support information. In use, the item map enables identification of items whose rating scale points are just beyond the student's calculated average score. These become the next focus for intervention. Figure 9 depicts this.



(Rating Scale Key: 1= does not perform; 2=partial performance; 3=inconsistent performance, and 4=consistent performance)

Figure 9. Scored item map for SFA 'Travel' with next intervention focus (Coster et al., 1998, p.37)

Notes: 'Travel' items on this map are arranged hierarchically in order of difficulty. Raw scores are converted to the 100-point scale that marks the horizontal difficulty continuum. Rating scale points (numbered 1 to 4) are arranged against their respective item according to their degree of difficulty (assigned by the Rasch PCM [Masters, 1982]). The vertical orange line represents the student's score as their 'average performance' and the dotted lines on either side the confidence interval ($\pm 1.96 \times \text{SEM}$). The black circled numbers are the student's actual score for each item, and the red boxed numbers the skills closest to their current proficiency, hence, the next intervention focus.

Rating scales. A common feature of these seven tools is the use of a single, generically-described Likert-type rating scale to grade performance. As stated in the Assessment Principles section of this chapter, such scales pose difficulties for interpretation and reporting. Each assessor must draw from their own notional sense of what ‘average’, ‘adequate’, or ‘almost well’ means, which will vary according to their personal degree of harshness/leniency. In addition, a norm-referenced interpretation is elicited by terms such as ‘average’ – both defined and taken to mean ‘operating at the level of one’s peers’, a standard which will vary across contexts and assessors, with results only indicating the mean of all perceptions, while presumed to be definitive.

A second concern is the description of the lower rating scale points, which are expressed in negative terms (e.g., ‘not close’, ‘well below average’, ‘partial’, ‘less adequately’) against the normative ‘achieved/competent’ goal, rather than by positive descriptions that describe the nature of progress or interim learning stage reached. The SFA provides the closest to informative, positive description, through prompts such as “makes meaningful attempt”, “sometimes initiates” and “completes to time and level expected” (Coster et al., 1998, p.27); however, these are not free of comparative language and pseudo-counts (‘meaningful’, ‘sometimes’, ‘expected’). If these assessments are to inform teaching and learning, then what is needed is positive content descriptions at each threshold step so the outcome at the micro level is meaningful transitions, and at the macro level, qualitative advance, ideally with larger level descriptions also usefully described. The SFA provides an example of a more positive description in relation to the skill, “Moves on uneven surfaces”, where ‘partial performance’ is defined as attempting to move independently and ‘inconsistent performance’ means ability to move over some rough surfaces (Coster et al., pp.27-28). The difficulty here is the lack of information about *what* is improving each time.

The main critique of negatively slanted generic rating scales is that the work involved in plotting their progression points, made possible by the Rasch model (1960, 1980), does not yield greater meaning about the latent trait. Were these scales replaced by a unique set of advancing proficiency indicators, or rubrics for each item, fully criterion-referenced to how learning progresses in the domain, interpretation could be brought from the relative difficulties of the items to the level of the positively described, advancing stages of learning. This would produce meaning along both ‘horizontal’ and ‘vertical’ planes and provide an added layer of assistance to intervention and instructional decision-making.

Implications for this Investigation

Rasch (1960, 1980) item-response modelling enables assessment results to be interpreted as relative trait possession. Two options become possible – an interval-level difficulty scaling of test tasks (the horizontal dimension), and a difficulty scaling of underlying domain processes that enable achievement of increasingly difficult tasks (the vertical dimension) (Karmiloff-Smith, 1981; Karmiloff-Smith & Inhelder, 1973). The first answers the question, ‘*What are the relative difficulties of a set of domain-indicative skills?*’ and the second, ‘*What does advancing learning proficiency in this domain entail and look like?*’ The first informs as to the relative standing of test-takers against a skill set with known levels of difficulty, while the second describes developmental learning stages, also with known difficulty indicators. In addition, the first references tasks that are *indirect* measures of the construct which can be exchanged for other tasks, while the second expresses the construct in behavioural form *directly*. Finally, the first orders *unlinked* tasks of the construct by difficulty, whereas the second orders *linked* proficiency levels; in other words, the first identifies *what* the test-taker can and cannot do (for example, draw with a pencil but not write with a pen) but not *why* the next step might, or might not, involve learning to write with a pen, reasons of underlying proficiency development that the second scale provides. This

deeper search, more approximate to unearthing the latent trait, involves describing what progressive approximation of the target behaviour looks like, through discovering the organizing or ordering principles that relate different aspects of domain behaviour (Krathwohl et al., 1964).

If learning only involves unstructured acquisition of more information or skills, then a scale of less to more of the goal product would be sufficient for instructional planning, but when domains exist in some quantity and progressive conceptual reorganisation is required for advance, a scale supporting instruction must uncover the (vertical) nature of that development. In relation to movement and motor skill acquisition, as noted in Chapter Three, expert movement is not many excellent moves, but learning *how* to move one's body in the best possible way to meet the requirements of task and context, and this involves a process of conceptual reorganisation (Nyberg, 2014). Creating a proficiency scale for this developing skill equates to the second of the above options, requiring an assessment purpose of identification of ZPD (Vygotsky, 1978) – the purpose of formative assessment (Black & Wiliam, 1998b). This is a feature of a developmental learning approach to assessment design in education (Griffin, 2001 2007, 2018; Griffin et al., 2004; see also Masters, 1994, 1998; Masters et al., 1990; Rowe & Hill, 1996; Wilson, 2005), to be discussed next.

A Developmental Learning Approach to Assessment Design

Griffin's (2001, 2007, 2018; Griffin et al., 2004) application of a developmental learning framework approach to assessment design was a response to the needs of teachers for informative (formative) assessment to guide instruction and to support assessment interpretation – the most difficult aspect. Its theoretical and psychometric underpinnings drew on:

- Vygotsky's (1978) proposal of a zone of learning readiness between what is known and what is still out of reach where teaching should be optimally focused,

- Glaser's (1981) understanding of criterion-referencing as referring to qualitatively distinct learning stages, and
- the Rasch partial-credit model (Masters, 1982; Rasch, 1960, 1980; Wright & Masters, 1982) that enables students to be located against the proficiency indicators of their current stage of learning.

The contributions of these influential thinkers have been outlined previously in this chapter and Chapter Two. The developmental learning approach combining their insights recommends the following series of steps be undertaken, in combination with referencing the research literature and drawing on subject matter expertise (Griffin, 2007, 2018):

1. *Define the learning domain*

Referencing the scholarly literature, name and define the domain suited to the assessment purpose and target population, list main aspects commonly mentioned, identify indicative skills within these aspects, and note conceptions of learning progress – also called learning taxonomies, after the work of Bloom and colleagues on taxonomies of educational objectives (Bloom, 1956, Krathwohl et al., 1964). This step produces a hypothesized conceptual model for later empirical testing (Griffin, Francis, & Robertson, 2018). In the case of this investigation, the findings from Chapter Three's review of the movement literature has provided a response to these four requirements of conceptual model development. Figure 10 depicts this information in a hypothesized framework developed thus far:

<i>Domain and definition:</i>	<i>Aspects:</i>	<i>Suggested indicative skills:</i>	<i>Descriptions of growth:</i>
GOAL-DIRECTED MOVEMENT: <i>A problem-solving strategy using the resources of the body to achieve movement-related goals</i>	1. Balance and postural control	Maintaining balance and postural stability	...Top
			...Mid-stage
			...Beginning
	2. Mobility	Positioning for engagement	...
			...
		Moving from one place/ position to another	
		Transporting objects	
	3. Manipulation	Responding to sensory cues to avoid obstacles	
		Remembering movement sequences	
		Managing personal belongings	
		Using games/ activity equipment	
		Using writing tools and classroom equipment	
	4. Communicative/ interactive skills	Regulating bodily tension	
		Gesturing interpretably	
		Responding appropriately in shared space	
	5. Performance sustainment	Achieving strenuous movement tasks	
		Persevering with physically demanding tasks	
		Regulating involvement within safe limits	

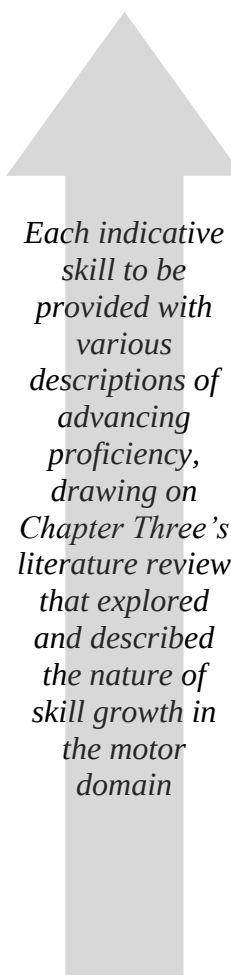


Figure 10. Hypothesized learning assessment framework the domain of interest

2. Confirm and finalise a set of observable and teachable domain skills

Work with subject matter experts to confirm and finalise the hypothesized indicative skills, ensuring their importance, observability, and availability to being taught in classroom settings, and their sufficient coverage of the domain and its aspects (the horizontal dimension of the scale) – exhaustive coverage being neither required or recommended (Griffin & Care, 2012).

3. Devise a set of advancing proficiency steps, or rubric, for each skill

Again, working with the expert group and drawing on the literature about nature of learning growth in the domain, as previously mentioned, devise a set of observable statements for each skill that express important markers of advancing proficiency – threshold shifts in performance. The same number of criteria for each skill is not needed, and more than four criteria per skill risks too finely graded a rubric for assessor judgement accuracy (Griffin, Gillis, & Calvito, 2007; Griffin, Francis, & Robertson, 2018). More important than quantity are criteria able to discriminate between levels of performance proficiency. This crucial step involves following rules for writing quality rubrics that stipulate they must:

- Describe skills contributing to a qualitative understanding of the level of proficiency reached, not counts in terms of things right and wrong, time requirements, or pseudo-counts (e.g. some, many).
- Use non-ambiguous language to define quality of performance, not comparative terms requiring each assessor to use their judgement as to what ‘good’ or ‘superior’ means.
- Describe increasing levels of quality performance, not procedural steps describing sequences of operations that may not reflect increasing difficulty.
- Describe well differentiated progressions in performance, using developmental taxonomies to define the nature of these qualitative shifts.
- Describe evidence for one idea only, to make marking easier and improve reliability.

- Describe positive behaviour – rather than lower stages being expressed as deficits.
- Cover the capacities reflective of the cohort – ensuring sufficient difficulty of top level descriptions to cater for and extend the most capable.
- Avoid weighting rubrics as harder or easier – self-weighting occurs within a criterion-referenced approach (as described in the next step 4).
- Consist of four or fewer criteria, as more levels makes distinguishing between levels of proficiency difficult for assessors.
- Aim for simple, clear language, understandable to everyone (Griffin et al., 2004).

4. *Make a judgement about the relative difficulty of the item steps of the scale*

Continuing with the expert group, perform a preliminary judgement-based calibration of the learning proficiency statements, pair-comparing them against each other to establish their relative difficulty and ensure there is sufficient coverage to the abilities and learning potentials of the target students (Griffin et al., 2004, 2007; Thurstone, 1927). This involves weighting the statements against each other by placing them relative to each other in their vertical columns, as the example of Figure 11 shows.

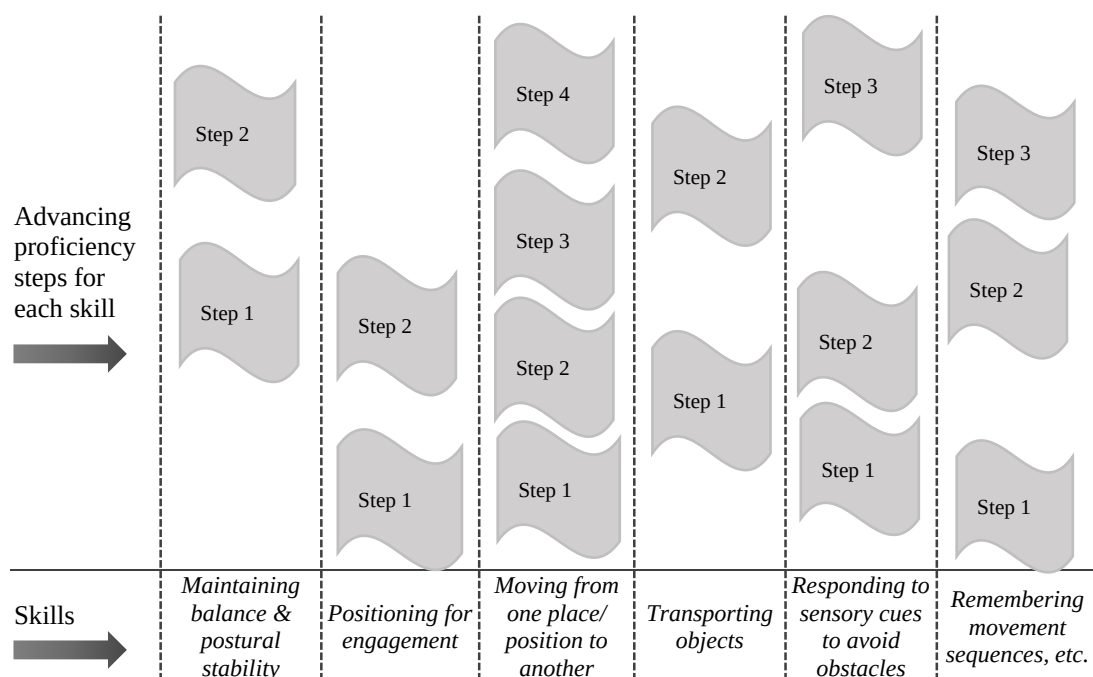


Figure 11. Differential weighting judgement matrix (Gillis et al., 2004, p.31)

5. *Pilot and amend the set*

Conduct iterations of piloting and review with a range of stakeholders who are familiar with the target population, to further improve the items and their growth indicators/ rubrics.

6. *Calibrate the set*

Empirically validate the hypothesized progression by large-scale trial, using a statistical package such as ACER ConQuest IRT software (Adams, Wu, & Wilson, 2015), which produces CTT and IRT statistical output that establishes instrument quality, including extent of fit to the Rasch model (1960, 1980) requirements of unidimensionality and other reliability and validity information.

7. *Establish multiple logical breaks between skill clusters and performance aspects*

This step involves further collaborative work with the expert group that devised the instrument, who work with the calibration study results, identifying item groupings that can be described as qualitatively advancing levels of performance.

As has been noted, Glaser's (1963, 1981) understanding of criterion-referencing contrasted with a checklist approach, in that his goal was not itemised lists of progressively more difficult skills, but descriptions of how learning unfolded and could be progressed in educational domains. The added standard setting step, creating and describing larger performance levels along the learning progression, provides a means for protecting criterion referenced interpretation from devolving to a checklist approach (Glaser, 1981; Griffin, 1997). Criterion referenced interpretation refers skills to a continuum of increasing difficulty, placing the skills in order. Standards-referenced interpretation grades the *quality of execution* of the skill and groups performances of similar quality together, to create the ordered, standards-referenced framework.

In conclusion, Griffin's (2001, 2007, 2018; Griffin et al., 2004) developmental model of learning that synthesizes the educational insights of Vygotsky (1978), Glaser (1963, 1981)

and Rasch (1960, 1980), and the consequent developmental learning approach to assessment design suggests a useful model for application to this investigation's goal of developing a learning progression in goal-directed movement for classroom teacher use.

Implications and Research Questions

The purpose of this investigation is to establish a developmental learning progression in classroom-related goal-directed movement for students with motor performance needs. This requires drawing on educational expertise in devising learning progress measures, and occupational therapy expertise in physical disability and motor skill acquisition. The tasks include establishing the construct's multidimensionality and major transition stages, best formats for reporting results in relation to the needs of different stakeholder groups, and impact of student background characteristics on achievement in the construct, particularly impairment severity (OTA, 2012; Ott & Effgen, 2000), and impairment bodily location (upper- or lower-body) (Hoy et al., 2011; McHale & Cermak, 1992; McMaster & Roberts, 2016).

In the context of a poorly developed curriculum engagement with classroom-related movement, and the absence of learning framework underpinnings for paediatric motor assessments, development of this construct as a learning domain will draw upon the complementary disciplines of education and health to offset oversights in each. Vygotskian constructivist theory, psychometric approaches to instrument construction, and educational approaches to standard-setting will be adopted, and scholarship and practice in motor skill acquisition accessed. Two studies are proposed – the first, to establish the learning progression (Forster & Masters, 2004; Griffin, 2007), and the second to identify the broad stages of acquisition along its length, and its optimal reporting formats.

Research questions.

The research questions address the aspects of this work sequentially, with the first study responding to the first two questions, the second study addressing the third question, and the fourth question using the results of both studies to test two directional hypotheses: that students with severe/profound impairments will perform lowest on the learning scale, and that students with upper limb impairments will perform more poorly than those with lower limb impairments, due to the dominance of upper-body fine-motor requirements in the classroom:

- RQ1. What is the typical developmental learning progression of goal-directed movement for students with motor performance needs?
- RQ2. To what extent is the developmental learning progression for goal-directed movement a multidimensional construct?
- RQ3. What are the major stages of skill acquisition in the development of goal-directed movement capability for students with motor performance needs, and how are results best reported to meet the needs of different stakeholder groups?
- RQ4. How do student background characteristics influence the development of goal-directed movement in students with motor performance needs?

The next chapter provides the methodology of the two studies.

Chapter Five: Methodology of the Investigation

This chapter is organised into two parts, describing the methodologies for the two studies, with the results reported in the four chapters following. Each part of the current chapter contains five sections: firstly, the purpose for each study and the research question(s) it answers, secondly, a description of the target group, thirdly, development of the data-collection instruments, fourthly, data collection procedures, and finally, the data analysis approach taken in each study.

Study 1 – Scale Development and Calibration

Purpose of the Study

The purpose of this study was the development and calibration of a scale measuring goal-directed movement in students with motor performance needs, that would support intervention decision-making by identifying what was ready next to be learnt. It sought to answer the first two research questions:

RQ1: What is the typical developmental learning progression of goal-directed movement for students with motor performance needs?

RQ2: To what extent is the developmental learning progression for goal-directed movement a multidimensional construct?

This involved developing a draft instrument that was grounded theoretically and drew on subject matter expertise, and firstly, trialling it with students with and without motor impairments to ensure all skills across the range were calibrated and the items operated invariantly for the target group. Following data analysis and expert review to improve any poorly performing aspects in relation to these requirements, the main study followed,

targeting students with motor performance needs to determine a learning progression and investigate statistical support for useful subdivisions of this scale.

Target group

Sample composition. The study involved assessment by participant assessors (hereon referred to as ‘assessors’) of students from the target group (i.e., students with motor performance needs). Assessors could be any school staff member with knowledge of the classroom motor performance of the student(s) they chose to assess, and could include classroom teachers, movement specialist educators (physical education and dance teachers), education support staff/teaching assistants, special education coordinators, or school-based health professionals involved in classroom physical skill development/remediation (occupational therapists and physiotherapists). The student sample was required to represent the population to which the data would be generalized (Hoffman, Bennett & Del Mar, 2013), being students with classroom-related motor performance needs, and to result in sufficient data collected at each threshold level to establish the validity and usefulness of the tool across the range (Joncas, 2007; Wu et al., 2016). In consequence of these requirements, and because physical difficulties accompany many disability conditions beyond those labelled physical, the sampling design included not only the state’s four physical disability specialist schools, but all 90 state special schools, and mainstream primary and secondary schools with a sizable cohort of students identified within the seven categories of the Program for Students with a Disability (PSD), used in Victorian schools to make funding applications (Department of Education and Training, 2017). It was assumed that within these categories, physical difficulty would occur to different degrees, including no difficulty at all, therefore that this sampling would enable all skills across the scale to be calibrated.

Method of recruitment. Non-probability sampling methodology was followed. Permission to conduct research in schools in Victoria was, at the time of the study, at the

discretion of the principal (Department of Education and Training, 2015a). Therefore, the recruitment process involved the following steps:

1. Principals were contacted by phone and their school's participation sought.
2. On the principal's verbal expression of interest, a follow-up email was sent, containing their Plain Language Statement and Consent form.
3. Once the principal's written consent was received, the school was registered with the University's online server that contained the judgement-based questionnaire, and the principal was concurrently emailed soft-copies for dissemination of the teacher/ assessor and parent Plain Language Statements and Consent forms (see Appendix C for documents and permission forms provided to participants). Principals were notified that each assessor and parent had to give their own written consent before becoming involved, though parent consents did not need to be returned to the researcher, thus ensuring privacy. These were retained by the school. An offer was also made to the principal for the researcher to present to staff the study's rationale and process to be followed, including the time-frame for data-collection.
4. Schools returned their assessor consent forms to the researcher, and data collection commenced, with each consenting participant choosing the student/s they wanted to assess from the group provided with parent permission. In this selection they were free, with no number stipulated, and encouraged to choose students known to them from across all levels of physical capacity, to ensure representative spread of abilities and characteristics. They then accessed the online demographic questionnaire and observation instrument, and after completing the demographic information, selected for each survey question the most appropriate partial-credit option to describe their student's goal-directed movement capability. These were then immediately uploaded

to the University of Melbourne server, which collected and stored the data ahead of analysis by the researcher.

Instrumentation

This section explains the methodology used to develop the student demographic questionnaire and the instrument used to gather data from the assessors of the student's level of goal-directed movement development.

Development of the demographic questionnaire. To complete the online survey, assessors were required to firstly complete brief, de-identified background information about themselves and the student they were assessing. Background assessor information required to establish assessor credibility included school role, length of time teaching, previous experience with students with different kinds of disabilities, and length of time involved with the student.

Student information for the trial sought disability categorisation within the seven PSD categories, which provided a broad indicator of motor dysfunction and supported designation ease by non-health specialists. This was expanded for the main study with two categories suggested from the census literature (ABS, 2015) and the ICF (WHO, 2013), to support identification of motor performance needs across all diagnostic groups in better reflection of the census findings of Chapter Two, that statistically, almost twice the number of children with diagnosed physical disability have movement limitations. Table 11 sets out these student demographic aspects.

Table 11 *Demographic Information about the Assessed Students*

PSD categories of disability (<i>selecting all that apply</i>)	Assistance requirement (<i>selecting one option only</i>)	Impairment by bodily location (<i>selecting all that apply</i>)
1. Physical disability	- Extensive help or supervision	- Arms and fingers
2. Visual impairment		- Gripping
3. Hearing impairment	- Aids and appliances, cues and prompts	- Legs and feet
4. Severe behaviour disorder		- Medical condition restricting physical engagement
5. Intellectual disability	- Independent, but difficulty with extended tasks (e.g., walking, stairs, or bending)	
6. Autism spectrum disorder		
7. Severe language disorder with critical educational needs	- No assistance requirements	

The impairment by bodily location column (third column of Table 11) expressed impairment distinctions in relation to which part of the body was affected – legs and feet indicating lower body impairments and difficulties with gross-motor skills, and arms and fingers and gripping indicating upper body impairments and difficulties with fine-motor skills (Utley & Astill, 2008). The levels of assistance (second column) substantively described the levels of the Australian Bureau of Statistic’s Survey of Disability, Ageing, and Carers, being profound, severe, moderate, and mild (ABS, 2015). So, students with profound levels of limitation were defined as those requiring extensive help and supervision for all classroom motor tasks. Students with moderate to severe limitations required support of various kinds, such as aids (including mobility aids), cues, and prompts, and students with mild limitations were independent in the classroom, but had difficulty completing extended tasks requiring greater capacity or fitness.

Development of the goal-directed movement observation instrument. As noted in Chapter Three’s literature review, to describe the acquisition of functional movement is to

describe development in a psychological activity, not simply changes to musculature and biomechanical functioning, as “goal-directed movement is inextricably linked with perception, cognition, and social interaction, and motor skill acquisition includes developmental learning in all these domains” (Adolph, 2013, p.532-533; see also Adolph & Berger, 2006; Bernstein, 1996). Within the options proposed by Gentile (1987), and the instructions of Thorndike (1982) regarding the ‘what’ of measurement, the goal of this research to describe motor learning in the context of physical disability resulted in a construct referent of movement as a solution-finding or problem-solving *strategy*, not normative movement *patterns* or forms. This also supported functional movement as a learning domain within education, as it supported scholarly opinion regarding patient learning as a key mechanism of action in rehabilitation (Carr & Shepherd, 2006; Dijkers et al., 2014a; Ehlhardt et al., 2008; Gordon & Magill, 2012; Greber et al., 2007; Hart, 2011; Hart, Ferraro, Myers, & Ellis, 2014; Hart, Tsaousides, Zanca, Whyte, Packel, Ferrero, & Dijkers, 2014; Whyte & Hart, 2003).

The methodological approach adopted to construct the scale employed both theoretical and psychometric approaches to instrument design (Griffin, 2007, 2009, 2018; Wilson, 2005; Wolfe & Smith, 2007). It grounded the domain initially in the scholarly literature, which suggested definitions, important aspects, and indicative skills that began the process of “items design” (Wilson. p.44). The construct of movement has been described in Chapter Three’s literature review. Of the various categorisations noted, a five-way division was proposed, consisting of the three aspects most commonly referred to – balance, mobility, and manipulation, expanded to include communicative and interactive skills, and performance sustainment (Figure 10 in Chapter Four). This categorisation supported further understanding of the range of skills of this domain that would help to ensure representative domain coverage. Examples of skills within these aspects relevant to the classroom were identified.

This work was provided to subject matter experts for further review and development, following educational measurement guidelines outlined by Griffin et al. (2004) and Wilson (2005), which stipulated developing a criterion-referenced evidence framework using expert judgement, and Rasch (1980) modelling. This assumed the possibility of describing the construct as a progressive scale or learning progression (Black, Wilson, & Yao, 2011), with interval units of measurement expressing increasing proficiency.

As outlined in Chapter Four's literature review on the conceptual framework for the study, Griffin (2007) synthesized the work of Vygotsky (1978, 1993), Glaser (1963, 1981), and Rasch (1980) in his approach to instrument design. This investigation adopted a number of Griffin and colleagues' recommendations to achieving an undergirding learning progression, including engaging subject matter experts to draft a set of indicative items from theoretical specifications and their specialist knowledge, and defining the performance of these items developmentally as statements of partial-credit (Masters, 1982). Following this, these statements were aligned to each other by their relative difficulties, to identify broader stages, or levels, in which they were conceptually situated. Calibrating these statements empirically then supported the initial conception. The way this process was followed for this investigation will now be explained.

Engaging subject matter experts in development of the scale. A group of 20 special education subject matter experts were recruited from 12 Australian special education settings, who were identified as knowledgeable in the domain by representatives of the Victorian DET's Participation, Achievement and Transitions division. This group included teachers from schools for students with a physical disability, as well as special education curriculum coordinators, PE, aquatics and dance specialists, school-based occupational and physiotherapists, and a person with lived experience of disability. They were informed about the process leading to the identification of the aspects and example skills, as well as the

theoretical background of the methodology for their work, summarised in Figure 10 of Chapter Four (Griffin et al., 2004; Griffin, Francis, & Robertson, 2018). Across a series of three full-day workshops, they firstly, confirmed and finalised a set of observable and teachable domain skills using the aspects and examples provided by the research review (Chapter Three), secondly, devised unique statements of developing proficiency for each skill using the taxonomic descriptions of learning growth also supplied by the review of scholarship, and thirdly, engaged in an exercise of differential weighting to ensure the proficiency statements sufficiently covered the difficulty levels of the domain as relevant to the needs of the target group. Explanation of these activities follow.

Establishing the item-pool. The first task of the expert team was to confirm and finalise a set of indicative items within the five aspects of the domain, ensuring skill descriptions were positive and observable, allowed diverse means for their demonstration non-discriminatory of different movement capabilities, were free of ambiguity and technical terms, were succinct and self-explanatory, and expressed skills advanceable by teaching intervention. 18 indicators were proposed in this first stage of instrument construction, with the results shown in Table 12.

Table 12 *Development of the Trial Item Pool*

Domain aspects:	Observable indicators from subject matter experts:
Balance and postural control	Maintains balance and upright posture Orients in space Positions self for task engagement
Mobility (transporting self and objects)	Transfers from one position to another Moves from place to place Monitors speed and tempo of movement Avoids obstacles while moving Uses sensory information to anticipate and respond to task and activity requirements Manages school-based daily routines Remembers movement sequences and routines
Manipulation	Transports objects and equipment Manipulates and controls task objects (tools, equipment)
Communicative/ interactive skills	Expresses and communicates non-verbally Controls breathing Moves in shared space respectfully of others
Performance sustainment	Achieves tasks requiring fitness Sustains energy for duration of activity Self-regulates in respect of physical limitations

Devising proficiency steps. Consistent with the recommended criterion-referenced interpretation of the construct, the second task of the expert group was to continue to review the draft items, and to provide observable item-steps for the final selection requiring different degrees of ability to achieve, enabling assignment of partial scores (Griffin, 2007; Wilson, 2005). To achieve this task, they were provided with the rules for rubric writing (Griffin et al., 2001, 2004) noted in Chapter Four.

The expert group were instructed to think of individual students they knew with different levels of motor capacity and to devise up to four proficiency steps for each indicator that

would clearly distinguish students from each other. While they were instructed to consider the capabilities of students with very severe disabilities, to ensure beginning steps were sufficient to pick up entry-level skills, they were also encouraged to extend these descriptions with steps at the level where standard curriculum resources could notionally take over – around the stage of the second or third year of schooling. In the process of this work, the pool of items was reduced to 16, with the combining of some items (‘Maintains balance’ and ‘Orients self in space’; ‘Moves from place to place’ and ‘Transfers from position to position’), rewriting of some items (‘Controls breathing’ becoming ‘Regulates physical tension’; ‘Sustains energy for duration of activity’ becoming ‘Completes tasks involving strenuous movement’), and expanding of some items (‘Manipulates and controls objects’ to three indicators, in recognition of the different requirements associated with managing personal belongings, activity equipment, and the tools of classroom learning). An example of a draft item with its item-steps is provided in Table 13 (see Appendix E for the full trial set). The numbering of each step indicates within-item difficulty ranking only – the lowest number denoting entry-level ability, and the highest number referring to the skill of highest demand for that set. Between sets these numerical codes are not equivalent, nor required to be. A final option, coded 0, accounted for students yet to reach each first step.

Table 13 *Item 1 with its Item Steps*

<i>Category: Balance, Postural Control, and Positioning</i>			
<i>Item:</i>		<i>Item steps:</i>	
1	Maintains	1.1	Reacts to lost balance
	balance and	1.2	Explores limits of balance
	upright posture	1.3	Employs strategies to minimise instability when tipped
		1.4	Maintains balance and stability with attention elsewhere

Differential weighting of item steps by pairwise comparison. The final task of the expert group was to weight each proficiency step against all others, as depicted in Figure 11 of

Chapter Four, to establish the relative ability needed to achieve each one, and to support the goal of obtaining a differentiating score for each student (Griffin et al., 2004). IRT identifies the difficulty of a proficiency step by its discriminating capacity – its ability to differentiate between students on the construct (see the Data Analysis section of this chapter where this model is explored in more detail). Due to the non-requirement for equivalence, steps depicted at the same level (e.g., 1.1, 2.1, 3.1, etc.), do not necessarily entail the same degree of difficulty. This is illustrated by a comparison of Item 1 (above), with Item 16 (Table 14).

Table 14 *Item 16 with its Item Steps*

<i>Category: Performance Sustainment</i>			
<i>Item:</i>		<i>Item steps:</i>	
16	Completes tasks involving strenuous movement	16.1	Maintains energy output for duration of simple routine tasks
		16.2	Engages in occasional strenuous movement during activity
		16.3	Manages a strenuous activity at slowed pace, or with rest
		16.4	Completes strenuous movement activities comfortably

From this comparison, it can be seen that ‘Reacting to lost balance’ (1.1) is an easier skill than ‘Maintaining energy output for the duration of a task’ (16.1). Also, the increase in difficulty from one to the next proficiency step within an item is not necessarily uniform, nor across items is the difficulty increase from, for example, all step 2’s to all step 3’s the same. For example, the difficulty of moving from 5.1 (Cooperates with the next step of a routine) to 5.2 (Repeats a simple movement sequence in imitation or from memory) is small compared to what is required to move from 5.2 to 5.3 (Adapts a movement sequence to suit new circumstances), whereas for item 1, this situation is reversed. The implication of this is more levels of difficulty contained in the scale than the four depicted by the maximum number of item steps for each item. To identify these, once the numerical codes were assigned, the expert team placed the steps relative to each other on a single matrix, in a consensus-building exercise involving judgement-based calibration, or paired comparison (Thurstone, 1927). For

example, a proficiency step with the same numerical code as another, but requiring more ability to achieve it, would be given a higher column placing, and so on. This resulted in a visual representation of hypothesized difficulty weightings for all proficiency steps and established the extent to which there were sufficient number to describe each level (Griffin et al., 2007). Figure 12 provides an excerpt of the judgement matrix for Items 2, 3, and 14 of this investigation, with the full matrix appended (Appendix F).

	<i>Harder steps</i>	2.3 Regulates tension for changing energy demands	3.4 Manages performance involving more than one demand	14.4 Adapts new strategies to novel settings
			3.3 Practices moving under different conditions	14.3 Initiates attempt at more difficult aspects
		2.2 Uses a strategy to manage physical tension	3.2 Focuses on the sensation of moving	
			3.1 Attends to sensory aspects	14.2 Completes tasks within capacity with prompting 14.1 Participates for immediate outcome
	<i>Easier steps</i>	2.1 Reacts to stimulation or emotion		
<i>Item:</i>		<i>2. Regulates physical tension</i>	<i>3. Coordinates response to sensory input</i>	<i>14. Perseveres in movement tasks</i>

Figure 12. Excerpt of differential weighting judgement matrix

The ability level of the cohort envisioned for this rating scale resulted in a significant number of steps at the beginning level of skill; however, in consideration of students with mild motor performance needs, there were also extended items to support identification of their abilities and indicate directions for their growth.

A horizontal analysis of skills clustered at each difficulty level identified common features and enabled comparison with the original proposal of Chapter Three. The high degree of alignment found was not surprising, given this progression had been developed to

guide conception of the item steps. Figure 13 provides an excerpt of the hypothesized proficiency steps from the scale, clustered to the levels of the original progression.



Developmental Progression	Example Item Steps
Intuitive and creative movement in novel, time-dependent situations	Adapts movement strategies in response to more challenging settings. Adjusts and changes movement response to engage with equipment and requirements of activity. Completes strenuous movement activities comfortably.
Knowledge of many routines, multi-tasking, benefitting from past experiences	Manipulates and uses tools and materials with appropriate strength and control, while attending to other aspects of task. Transports objects even while engaged on other aspects of activity. Cooperates with others to share the space.
Routine movements modified for variations, exploration of different strategies, practice	Explores different ways to transport objects. Practices moving under different sensory conditions. Practices moving and repositioning to improve speed and energy efficiency.
Singular focus on movement task, attention to context, use of learned strategies	Employs learned strategies to navigate safely around obstacles in familiar settings. Follows instructions to use equipment. Focuses to move or reposition self in routine tasks. Focuses or slows to use tools and materials with appropriate strength and control.
Achievement of movement components with support (cues, prompts)	Achieves a component of equipment handling. Cooperates with the next step of a routine movement. Assists in being positioned for activity engagement. Participates for immediate positive outcome.
Reactive responses, awareness, and observation of others	Reacts when moved around obstacles and through narrow spaces. Shows awareness of being re-positioned or moved. Reacts to stimulation or emotion.

Figure 13. Alignment of item proficiency steps to the developmental progression.

Panelling and piloting. Before commencing empirical calibration of a scale, a process of review, involving groups who are familiar with the subjects of the trial is recommended (Wilson, 2005, Wolfe & Smith, 2007). Consequently, the instrument and demographic

questionnaire underwent three piloting exercises with a total of 20 teachers and specialist staff from three special education schools. These teachers had not been part of the original development process, and so could read the documents afresh. Their role was to identify issues with clarity and technicality of language, appraise the suitability of the items for different movement difficulties and conditions, review the scope of the scale in terms of alignment to range of student abilities, and suggest examples for each step to support assessor judgement. The process involved them responding to the items of the scale for two students and discussing their findings and concerns together at the conclusion (Wilson, 2005). They also completed the demographic questionnaire for each student, to ensure the wording of this document was clear. Changes were made from this work, including addition of suggested examples to the proficiency steps to better guide assessor interpretation, as it was noted that movement as a learning domain was not a strength for most teachers, and examples would assist clarity. Two items showing these additions are provided in Table 15, with other amendments made following the review in Table 16. In each, the changes are in italics.

Table 15 *Addition of Examples to Item Steps Following Piloting*

Item	Item steps with additional examples
Uses movement skills to avoid obstacles or prevent problems occurring	1. Reacts when moved around obstacles and through narrow spaces (<i>e.g., holds on, leans in</i>) 2. Attempts to avoid obstacles in familiar settings (<i>e.g., gives wide berth, or stops to wait for another to pass</i>) 3. Employs learned strategies to navigate safely around obstacles in familiar settings
Manages personal school equipment	1. Attends to equipment when placed in hand or nearby (<i>e.g. stills body, holds briefly</i>) 2. Achieves a component of equipment handling (<i>e.g., holds backpack while another closes it</i>) 3. Exploits possibilities of body and environment for managing equipment independently (<i>e.g., practices using different body parts to stabilise objects, or different ways to grip and operate backpack zip</i>)

Table 16 *Amendments to Item Steps Following Piloting*

Original	Concerns	Changes
1.3. Employs strategies to minimise instability when pushed or tipped (e.g., bends knees)	Difficult to observe employment of strategies – lack of clarity, and reservations about references to pushing or tipping students	<i>1.3 Focuses to maintain stable posture (e.g., attends to strategy, such as "feet flat, bottom back to sit up straight")</i>
5.3 Repeats a simple movement sequence in imitation or from memory (e.g. walks in walker once assisted into it)	Suggestion to add an example to cater for non-ambulating students	<i>5.3 Adapts a movement sequence to suit new circumstances (e.g., adapts movement for a different ground surface, changes strategy to reach accurately at different speeds)</i>
7.3 Employs learned strategies to navigate safely around obstacles in familiar settings	Teachers would have to infer that a student was employing a learned strategy – would not necessarily know this. Also, this step needs examples for clarity.	<i>7.3. Modifies movement to avoid obstacles that have proved difficult in the past, or that have suddenly arisen (e.g., slows or focuses attention to avoid a trip hazard)</i>
9.2 Explores different ways to transport objects	This is a general statement – difficult to score, needs to have better relationship to a clear skill level	<i>9.2 Concentrates to achieve transport of self and object(s)</i>

The review process concluded with a panelling of the items with an additional group of experts that included academics in educational measurement and special education, an adapted physical education specialist, and a member of the Victorian DET's Participation, Achievement and Transitions Division. This group confirmed the suggested changes to the items and demographic questionnaire ahead of the trial. The draft item-set was then prepared in an online format as a judgement-based questionnaire. Figures 14 and 15 show excerpts of the online questionnaire and survey, with the full trial survey provided at Appendix E.

INSTRUCTIONS: For each question, please choose **ONLY ONE** response. The response you choose should be the closest match to this student's typical performance. If you feel the student performance falls between two levels, select the lower one. This will indicate that the student has achieved that level but has not reached the higher one.

Movement - using the capacities of the body to achieve one's goals

Q1. Maintains balance and upright posture

- ☐ Reacts to lost balance (e.g., rights head, extends arms)
- ☐ Explores limits of balance (e.g., rocks to point of tipping, moves head in different planes or directions)
- ☐ Focuses to maintain stable posture (e.g., attends to strategy, such as "feet flat, bottom back to sit up straight")
- ☐ Maintains balance and stability even when attention is directed elsewhere (e.g., talks while walking, climbs stairs safely in a crowd)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Figure 14. Online excerpt of demographic questions

Please select the option that best describes your experience

Q1. How long have you been teaching?

- ☐ Less than 6 months
- ☐ 6 - 12 months
- ☐ 1 - 3 years
- ☐ 3 - 6 years
- ☐ 6 - 10 years
- ☐ Over 10 years

Q2. What is your primary role at this school?

- ☐ Classroom teacher
- ☐ Special education coordinator
- ☐ Specialist teacher of movement (e.g., physical education, swimming, dance)
- ☐ Other (please specify)

Q3. Have you previously taught, cared for or supported a child or young person with any of the following disabilities? (Mark all that apply)

- ☐ Physical impairment
- ☐ Intellectual impairment
- ☐ Sensory impairment (affecting sight, hearing or speech)
- ☐ Autism Spectrum Disorder
- ☐ Attention Deficit Hyperactivity Disorder (ADHD), Learning Disability (LD), or other emotional or behavioural concern
- ☐ Other (please specify)

Q4. How long have you been working with this student?

- ☐ Less than 3 months
- ☐ 3 - 6 months
- ☐ 6 - 12 months
- ☐ 1 - 2 years
- ☐ Over 2 years

Q5. Does this student have a diagnosis of physical disability?

- ☐ No
- ☐ Yes
- ☐ Don't know

Figure 15. Online excerpt of observational questionnaire

Trial and initial calibration of the draft instrument. Following panelling and piloting, a trial of the instrument was conducted of students from a wide a range of disability

backgrounds, to ensure calibration of all skills across the scale was achieved. This involved 61 Victorian schools, 328 assessors, and 1352 assessed students with a range of impairment conditions, including physical disability (23%), ASD (50%) and intellectual disability (75%). A clear, meaningful line of increasing proficiency in the underlying construct was sought, successfully spreading students by ability along the scale. The inclusion of students without physical disability supported calibration of all items and review of any with problems ahead of the main study.

Item review. Following the trial-run and initial calibration, a review panel met to consider improvements to the items ahead of the main study. This group consisted of a team of fifteen experienced special educators, physical education specialists, and therapists from thirteen schools, including all four physical disability special schools, one mainstream P-12 College, a school for Deaf children, two Autism special schools, and five schools for children with mild to profound intellectual disability, as well as a person with lived experience of disability, two academics from the University of Melbourne, and a representative from the Victorian DET. They were presented with the poorer performing items, identified by statistical results analysis, and provided recommendations for their improvement or possible removal. Following this process, the data-collection instrument was prepared in an online format in the same way as the trial item pool. The final set of 19 items was as follows (see Appendix G for screen shots of the full main study instrument):

1. Maintaining balance and upright posture (seated or standing)
2. Regulating physical tension
3. Coordinating response to sensory input
4. Positioning self to engage in activity
5. Remembering a movement sequence or strategy
6. Moving from one position or place to another (with or without mobility aid)

7. Using movement skills to avoid obstacles or prevent problems occurring
8. Using sporting or activity equipment (such as mats, balls, bikes, climbing equipment, musical instruments)
9. Obtaining objects
10. Transporting objects from place to place
11. Managing personal school equipment (such as bags, books, lunch, clothing)
12. Manipulating and using tools and materials (such as pencils, ruler, computer)
13. Using writing and drawing implements
14. Sharing space interactively with others
15. Using movement for self-expression and communication
16. Seeking out movement experiences and challenges
17. Persevering in movement tasks or activities
18. Working within physical limits
19. Completing tasks involving strenuous movement.

Data Collection

Data from the trial and the main study were collected by the University of Melbourne's Assessment Research Centre's Online Testing System (ARCOTS – education.unimelb.edu.au/arc/arcots). This internet-based system allows teachers to administer tests of student academic ability online, uploading their responses back to the server for computing of results.

Ethical considerations. Ethics approval to conduct this research in Victorian schools and engage teachers in survey completion was granted from the Human Research and Ethics Committee of the Melbourne Graduate School of Education, the University of Melbourne, and from the Victorian DET (see Appendix D for ethics approval documentation). The study was approved as a minimal risk study, as it involved teachers responding anonymously to a

set of online survey questions about student's motor abilities, based on their existing knowledge of the student, without need for student involvement.

Data Analysis

The item response modelling approach. The overall goal of the study was to achieve the placement of students at their point of emerging goal-directed movement capability, as the optimal place for their learning and instruction. To achieve this goal, the underlying measurement referent had to be unidimensional, so comparison of students by that attribute alone could be achieved (Fisher, 1993; Hambleton & Murray, 1983; Masters, 2005; Wilson & Hoskens, 2005; Wright & Masters, 1982). Rasch item response modelling (IRM) enabled the extent of success on this goal to be established (Rasch, 1980). As noted in Chapter Four, this measurement approach postulates that performance on an assessment item is sufficiently explained by the difficulty of the item and person ability in relation to the variable, or trait, being measured. Where person ability is greater than item difficulty, the probability of success exceeds 0.5, where it is lower, the probability of success falls below 0.5, and where item difficulty and person ability is equal, the probability of success is 50:50. The mathematical equation for calculating this uses the following symbols:

Item difficulty	= δ
Person ability	= θ
Measurement unit	= logit (log-odds of success)
Score probability	= P
Success on the item	= $X=1$
Difference between person ability and item difficulty	= $f(\theta - \delta) = \frac{\exp(\theta - \delta)}{1 + \exp(\theta - \delta)}$

The formula is thus:

$$p(X = 1) = f(\theta - \delta) = \frac{\exp(\theta - \delta)}{1 + \exp(\theta - \delta)} \quad (5.1)$$

In written form, this states that the probability ($p = 50:50$ chance) of success ($X=1$) on an item is a logistic cumulative function of the difference between a person's ability (θ) and a test item's difficulty (δ). Hence, a person of moderate ability has a 50% chance of getting a moderately difficult item right, and this chance changes with change of ability or difficulty parameter alone. For an item of a difficulty of 1, the item characteristic curve (ICC) depicting probability of correct response is shown in Figure 16:

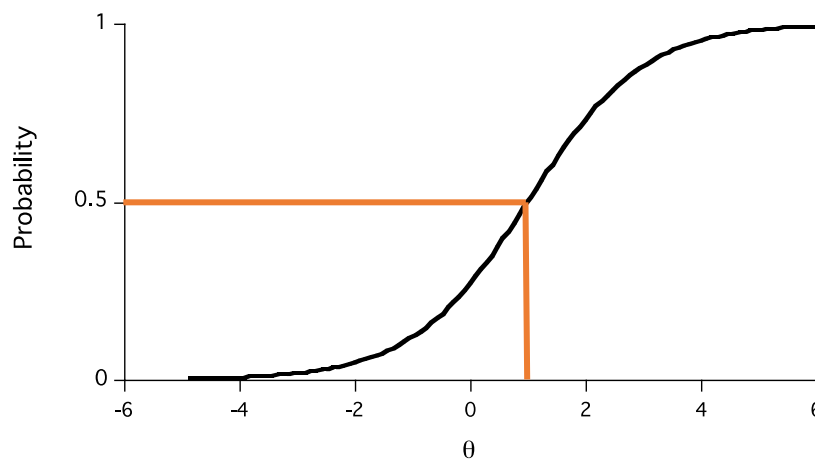


Figure 16. Rasch Item Characteristic Curve (ICC) (Wu & Adams, 2007)

The symbol θ refers to latent trait possession – both in the person, and in the item the person is attempting. The units of the horizontal scale are the logits – the “log odds” of success at substantively described, equal-interval gradations of the latent trait (Wu & Adams, 2007, p.29). The vertical scale therefore depicts the increasing probability of achievement. ‘0’ equals non-achievement and ‘1’ equals success. Between these two points, lies the ‘on-balance’ or probability zone, where likelihood of success and failure is equal. Thus, the ICC in Figure 16 is depicting that when an item of difficulty ‘1’ is attempted by a person of ability ‘1’, the chance of success is 50:50.

As there was more than one response option for each of the items of the goal-directed movement scale, and these were behaviourally anchored, with number, type, and difficulty of options varying across the scale, the Rasch Partial Credit Model (PCM) (Masters, 1982) was used to analyse results, as this does not constrain the thresholds to fixed difficulties as the

Rating Scale Model does (Andrich, 1978). This latter is suitable for polytomously scored items of Likert type, where the number and type of response is the same across the test (Engelhard, 2013). The prevalent use of Likert-type rating scales in health assessments was addressed in Chapter Four's literature review. While there may be cases where it is important that distances between rating scale steps have invariant meaning across all items; for example, where points on a Rasch rating scale indicate a certain kind of treatment or support is required, or that independent living is likely to be unsafe – an example of this being the Assessment of Motor and Process Skills (AMPS), which has a logit 'benchmark' below which it is not safe for a person to live independently in the community (Fisher & Jones, 2011). However, this form of scoring rarely reflects life's realities, as seen in a comparison exercise examining data using both models, where the rating scale model produced a significantly worse fit (Adams & Wu, 2010). Overall, the Rating Scale model has restricted usefulness in comparison to the Partial Credit model (Wu et al., 2016).

The Partial Credit Model. In test items where questions have more than one possible answer, with intermediate levels of correctness amongst those options that are different across different items, scoring can reflect this by assigning unique partial credit to each step of each item. Masters (1982) applied the Rasch dichotomous model to this situation, by viewing each pair of options in the larger set as dichotomous cases. For example, in the case of a 3-step item, where achieving each subsequent step requires greater proficiency than the step before, a student can be scored anywhere from zero to 3. At each parameter point, a boundary line is conceived as having been reached, and successful achievement of the boundary question becomes the requirement for moving to the next parameter. Students are therefore graded as either achieving the first step ($X=1$) or not achieving it ($X=0$) at the first point, achieving the second step ($X=2$) or not achieving it ($X=1$) at the second point, and so

on. In terms of mathematical formula, for a probability of success moving from score 0 to score 1:

$$p_{(1/0, 1)} = \frac{\Pr(X=1)}{\Pr(X=0)+\Pr(X=1)} = \frac{\exp(\theta-\delta_1)}{1+\exp(\theta-\delta_1)} \quad (5.2)$$

and for a probability of success moving from score 1 to score 2:

$$p_{(2/1, 2)} = \frac{\Pr(X=2)}{\Pr(X=1)+\Pr(X=2)} = \frac{\exp(\theta-\delta_2)}{1+\exp(\theta-\delta_2)}, \text{ and so on.} \quad (5.3)$$

The probability of each score considering all score possibilities collectively can also be calculated. This is stated as the probability of person n scoring x on polytomous item i containing k score categories, and is given in equation form as:

$$\Pr(X_{ni} = x) = \frac{\exp \sum_{k=0}^x (\theta_n - \delta_{ik})}{\sum_{h=0}^{m_i} \exp \sum_{k=0}^h (\theta_n - \delta_{ik})} \quad (5.4)$$

Partial credit steps should be placed in order of increasing trait requirement or difficulty, so that more able students achieve higher scores. This is not the same as saying that partial credit steps are sequential and can only be achieved in order. The item response model is probabilistic and works with likelihoods – while higher ability students have a greater likelihood of achieving easier steps than students of less ability, they may yet fail them, and conversely, the lower-performing students may achieve difficult steps (Wilson, 2009).

Depicting results – the item-threshold map. Following data collection, the difficulty estimates for each of the uniquely described partial-credit steps were obtained and represented visually on a map providing detail to this level – for the purposes of this study, this is hereon referred to as an *item-threshold map* (i.e., a version of a Wright map, as discussed in Chapter Four’s literature review).

Residual based fit statistics for the Rasch model. Measures of item-fit establish the degree to which the items predicted responses, in this case, how well the goal-directed movement items predicted construct ability in students with motor performance difficulties. If an item fits to the Rasch model well, its predictions of difficulty are matched by the results, so that

difficult item steps are achieved on balance by high-ability students, and students of low-ability are more likely achieve less difficult steps (Wu et al., 2016). This bears out the Rasch model prediction that probability of success on an item is due to the item's difficulty and the person's ability only (see equation 3.1 previously). Where other factors have influenced the outcome, the fit of the item to the Rasch model is compromised. These other factors include differential item functioning (DIF), where items function differently for different sub-groups, and violations of unidimensionality, where items inadvertently test additional, unintended domains.

Item fit. Residual based fit statistics for items are the unweighted (outfit) and weighted (infit) mean-square (WMNSQ), which compare observed and expected responses (Wu & Adams, 2013). The weighted mean-square has incorporated the variance of item response into the statistic, recognising that students performing closer to the difficulty of the item supply more information about the item than students whose abilities are very different. It is therefore a more robust measure of an item's discriminating ability and is used in this research. Mean-square statistics have an expectation of 1 for closeness of fit. Items can come in above or below that ideal to a greater or lesser degree, indicating underfit and overfit respectively. While the Rasch model does not stipulate what range of infit mean-square values constitutes acceptable fit, a rule of thumb of 30% variation for judgement-based assessments is generally supported, in other words, outer limits of 0.75 and 1.33 (Adams & Khoo, 1996; Griffin, 1999; Wilson, 2005; Wright, Linacre, Gustafson, & Martin-Lof, 1994). An underfitting item, resulting from greater randomness in assessor response, is considered more problematic, as it discriminates less clearly between different abilities, whereas an overfitting item provides greater discrimination than other test items, and should generally be retained.

Graphically, ACER ConQuest IRT software (Adams, Wu, & Wilson, 2015) allows underfit and overfit for partial-credit items to be represented by Expected Scores Curves (ECCs), which clearly compare modelled predictions to observed scores for each proficiency step, or score category (Adams et al., 2015). For example, Figure 17 depicts an item with four possible responses that has an underfitting weighted mean square of 1.46.

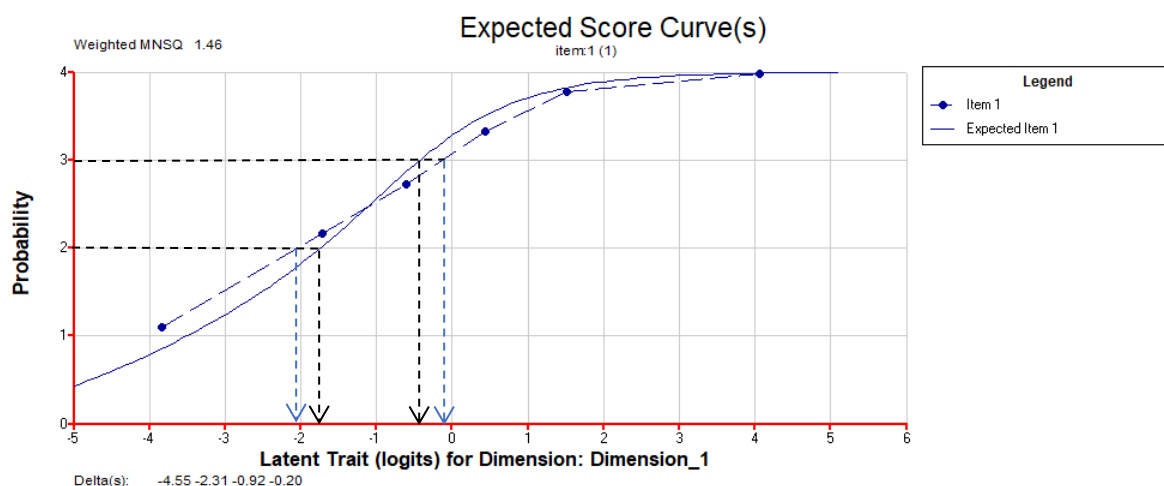


Figure 17. Performance of an under-fitting partial-credit item

Figure 17 shows the probability of achieving each of the four options on the y-axis, and the difficulty range of the item in logits on the x-axis. The blue solid line represents the model response, and the broken line the observed response. The broken line is flattened, indicating there is a greater probability than the model predicted of lower ability students receiving scores of 1 and 2, but reduced likelihood of higher ability students receiving a score of 3. This demonstrates the usefulness of statistics and graphical representations to flag issues with fit, though noting the importance of subjecting problematic items to analysis at content level, as has occurred in this study via the analytical work and recommendations of the subject matter experts following the trial.

Person fit and differential item functioning (DIF). Invariance of item parameters is an important Rasch-model property and theoretical ideal, and DIF is the method used to examine extent of achievement of this invariance, via identification of differences in group

performance that differences in relative possession of the latent trait do not explain (Andrich & Hagquist, 2012). In situations where it can be shown that items have functioned differently for a subgroup, for example, giving movement tasks requiring all four limbs to a student group that includes amputees, the likelihood of valid inferences about that subgroup's performance on the task is reduced. In the case of this investigation, the interest was to measure goal-directed movement capability, not normative movement ability, hence, it was important that items did not inadvertently require particular movement patterns or forms to achieve the movement goal. The presence of a high infit statistic was used to indicate the possibility of DIF, upon which the item difficulty was calibrated separately for the sub-group, then compared to the whole (Wu et al., 2016). Where DIF existed, the content of the item was examined to establish possible reasons, and these guided response decisions. Overall, consideration was given to the effect of the DIF on the mean ability estimate of the target group, which is calculated as the sum of the number of items evidencing DIF/ the number of items in the assessment.

Establishing reliability and validity. As a psychological activity (Adolph, 2013), goal-directed movement capability is not directly visible, nor easy to define; it can only be inferred through observation of its indicators, and these must be verified as measuring the variable (Carr & Shepherd, 2006; Wu et al., 2016). The tendency to measure different constructs inadvertently has been noted in rehabilitation measures that were not developed to meet the requirement of unidimensionality, resulting in their loss of reliability and validity (Fisher, 1993; Fisher, 1994; Hobart, Cano, Zajicek & Thompson, 2007; Kielhofner, 2006) – see the section on reliability and validity in Chapter Four's literature review for a more detailed discussion.

Reliability. The reliability of a test is a measure of how well it can establish the capacity of students on the construct being tested, with sources of possible error being the internal

consistency of the test items themselves – how well they ‘hang together’ to elicit the skill in question, variations in scorer stringency (inter-rater reliability), variations in scorer reliability over time (temporal, or intra-rater reliability), and error due to chance (Wu et al., 2016). Consistency of test items is the most important consideration, as problematic items cause most response variation. Consequently, two approaches were followed in this study to determine reliability – firstly, the internal consistency of the items was established via the coefficient alpha (Cronbach, 1951) as recommended by classical test theory (CTT), and secondly, the degree of item-separation reliability was established via the Rasch separation index (Wright & Masters, 1982). Both these reliability indices were obtained through ACER ConQuest IRT software (Adams et al., 2015). Cronbach’s approach establishes test reliability by mimicking the correlation of results on two tests with similar items. The process followed splits a single test and correlates the halves, to achieve a lower bound estimate of test reliability by using variance in observed scores and errors arising from all possible ways of splitting the test. The possible range falls between 0 and 1.0, with high reliability indicated by closeness to 1.0. This, however, does not estimate reliability at the item level. The Rasch separation index establishes the separability of items along a variable. Where there is adequate separation between items, or item clusters, and they span the length of the variable, their threshold locations permit its explication and establish that the same variable is being measured in every case. Again, high item-separation reliability is indicated by a score close to 1.0. The Rasch model also indicates person-separation reliability – how well the items achieved separation of test-takers by their ability. High person-separation reliability, again indicated by closeness to 1.0, requires good alignment of item difficulties to person abilities, established by computing standard error of measurement, or degree of alignment of individual scores to variation in scores across the group (Andrich, 1982).

Validity. Validity examines the extent to which the construct that is the focus of assessment has been measured by its items, and that inferences drawn from results are substantiated and justified, not only from empirical evidence, but also in terms of social and ethical outcomes (Kane, 1992; Messick, 1995). An assessment is only credible if it is valid, hence validity must be established (AERA, APA, NCE, 1999). This involves a process of gathering evidence that begins with the specification of the construct and its purpose and continues through all the activities of assessment design and calibration (Wolfe & Smith, 2007).

Content validity considers the representativeness of the construct and the capacity of the items to represent the construct, and structural validity addresses the degree to which the outcomes reflect underpinning domain theory (Wolfe & Smith, 2007). This validity requirement is supported by engaging domain experts in iterative review during construct and item development. Consequently, this investigation grounded the conception of goal-directed movement in domain theory (as depicted in Figure 10 of Chapter Four), and utilised experts sequentially in scale construction and review, with the documentation of this process constituting a validity argument, as outlined earlier in this chapter, in the Instrument Development section. Following the data-collection study, the analysis of item fit considered construct validity - establishing the degree to which the items accurately measured the underlying construct, while analysis of person fit established the extent to which the construct abilities of all student groups were fairly comprehended by the items (Wright, 1995b).

The derived order of the items and their clustering together in larger bands, when compared to that hypothesized during instrument construction, also contributed to a validity argument, as it indicated the extent of alignment of outcomes with originating purposes as well as providing an ordered definition of the construct (see Appendix F, which presents the matrix). Consequently, for this investigation, as outlined earlier, expert judgement proposed

a difficulty scaling of item steps by paired comparison ahead of the trial and main studies.

Following this, results visually depicted on an item-person map indicated the derived order of difficulty of the item steps, and established how well the spread of item difficulties matched the original conception and the spread of abilities.

Finally, validity is supported by a unidimensional construct, as validity depends on the data fitting to Rasch model specifications, which are that item responses derive only from ability in the latent trait (Wu et al., 2016). From the scholarly literature, this investigation identified a unidimensional construct of goal-directed movement, but also noted research support for five sub-constructs as maximising the clinical usefulness of results. Discussion of multidimensional IRT analyses follows.

Multidimensional item-response theory (MIRT) and categorising usefully. While unidimensionality is a measurement requirement, the existence of complexity within constructs and the fact that composites of ability underlie all performance mean that reporting on aspects of a variable, may be preferable to single scores or reports (Ackerman, Gierl, & Walker, 2003; Briggs & Wilson, 2003; Wilson & Hoskens, 2005). In some cases, students have greater proficiency in some aspects of a skill set and hence develop at different rates across a scale, a situation not picked up by unidimensional analysis. Such sub-sets of skills may be highly correlated psychometrically, but educationally, and from a physical rehabilitation point of view, different enough to warrant separate categorisation and analysis. Multidimensional analysis involves hypothesizing sub-dimensions for a scale and loading respective items onto them – called “between item dimensionality” (Wu et al., 2016, p.284; see also Adams et al., 1997). This does not negate unidimensionality, as the latter refers to sharing in an underlying construct and not to a requirement for sameness (Wu et al., 2016). As a parallel example, changes in the body, such as greying hair and height reduction, share in a unidimensional ‘ageing’ construct, without being the same, or occurring in the same way

for every person. It is what makes the most useful contribution to the end-user that should structure construct description and report. In addition, where test items indirectly measure a construct, a single dimension report may be sufficient, but where items describe the construct directly, multidimensional analysis that details strengths and growth areas within band levels provides more comprehensive guidance to differentiation (Adams et al., 1997; Egan, Schneider, & Ferrara, 2012; Hartig & Hohler, 2009; Wu & Adams, 2006). This latter is the requirement for this investigation.

Establishing aspects is both part of instrument development work preceding test construction, and IRT empirical validation that follows field-testing (Adams et al., 1997; Wu & Adams, 2007). Consequently, this investigation engaged in pre-test construction work, identifying, from Chapter Three's review of the movement science and paediatric physical assessment and rehabilitation literature, various sub-divisions for the motor domain, including a comprehensive three-way proposal and a five-dimensional option as potentially most supportive of school-based end-users. The five-dimensional structure, which included the classroom-important aspect of communication/ social interaction, was developed as the conceptual model for testing in Chapter 4 (Figure 10) and used by the subject matter experts to develop the draft item pool. Following field-testing of the final 19 items, statistical comparison of the performance of the items according to these two different divisions was undertaken – the three-way division loading the items onto 1) maintenance and change of body position, 2) maintenance and change of object position, and 3) management and maintenance of physical engagement, and the five-way division loading them onto 1) balance, 2) transportation of self and objects, 3) manipulation, 4) communicative/ interactive skills, and 5) performance sustainment. Table 17 provides these specific allocations.

Table 17 *Multidimensional Categorisations of the Item Pool with Proposed Loadings*

3-dimensional categorisation		5-dimensional categorisation	
Dimension	Items	Dimension	Items
<u>Dimension 1:</u> Maintenance and change of body position	1. Maintaining balance and upright posture; 4. Positioning self to engage in activity; 5. Remembering a movement sequence/ strategy; 6. Moving from one position/place to another 7. Avoiding obstacles/ preventing problems 15. Self-expression and communication 19. Completing strenuous movement tasks	<u>Dimension 1:</u> Balance, posture, and positioning	1. Maintaining balance and upright posture; 4. Positioning self to engage in activity
<u>Dimension 2:</u> Maintenance and change of object position	8. Using sporting and activity equipment; 9. Obtaining objects; 10. Transporting objects from place to place; 11. Managing personal school equipment; 12. Manipulating and using tools and materials; 13. Using writing and drawing implements	<u>Dimension 2:</u> Transportation of self and objects	3. Coordinating a response to sensory input; 5. Remembering a movement sequence/ strategy; 6. Moving from one position/place to another; 7. Avoiding obstacles/ preventing problems; 10. Transporting objects from place to place
<u>Dimension 3:</u> Management and maintenance of physical engagement	2. Regulating physical tension; 3. Coordinating a response to sensory input; 14. Sharing space interactively with others; 16. Seeking out movement challenges; 17. Persevering in movement tasks; 18. Working within physical limits	<u>Dimension 3:</u> Manipulation and use of objects and tools	8. Using sporting and activity equipment; 9. Obtaining objects; 11. Managing personal school equipment; 12. Manipulating and using tools and materials; 13. Using writing and drawing implements
		<u>Dimension 4:</u> Communicative/ interactive skills	2. Regulating physical tension; 14. Sharing space interactively with others; 15. Self-expression and communication
		<u>Dimension 5:</u> Performance sustainment	16. Seeking out movement challenges; 17. Persevering in movement tasks; 18. Working within physical limits; 19. Completing tasks involving strenuous movement

Summary of Study 1

This section has described the methodology of Study 1, of which the aim was development and calibration of a scale, underpinned by a theory of developmental learning, that measured goal-directed movement capability in response to the first and second research questions:

What is the typical developmental learning progression in goal-directed movement for students with motor performance needs?

To what extent is the developmental learning progression in goal-directed movement a multidimensional construct?

Results of this work are reported in Chapters Six and Seven. The next section of this chapter sets out procedures followed to establish standards for this scale, explore the impact of impairment severity on performance, and identify optimal reporting formats for different stakeholder groups.

Study 2 – Standard Setting

This study concerned the setting of standards for the goal-directed movement capability learning progression, and consideration of report formats for different stakeholder groups. The process involved a Delphi panel of three iterative rounds, noted in Chapter Four as providing best support to consensus attainment amongst subject matter experts in the health profession of occupational therapy. This chapter section again contains five methodological aspects: the study's purpose, a description of the target population including demographic questionnaire and ethical considerations, the process of instrument development, data collection procedures, and the method of data analysis.

Purpose of the Study

This study was conducted in response to the third research question, which asked:

What are the major stages of skill acquisition in the development of goal-directed movement for students with motor performance needs, and how are results best reported to meet the needs of different stakeholder groups?

In establishing these stages, the purpose of the study, in keeping with the literature on learning advance and intervention decision-making best-practice (see Chapter Two's literature review), was to enable identification of learning stages in goal-directed movement. Therefore, this study involved two aspects:

1. A Delphi consensus-building process with paediatric occupational therapists experienced in motor skill development in classroom settings, and
2. The use of Bookmark standard-setting methodology (Cizek & Bunch, 2007; Lewis et al., 2012), by which these therapists established standards for the scale and gave opinion about optimal reporting formats for different stakeholder needs.

Target Group

The constitution of panellists is considered the “lynchpin” of the Delphi method (Green et al., 1999, p. 200; see also Clayton, 1997). As noted in Chapter Four, it is recommended that inclusion and exclusion criteria for selection of panellists be decided beforehand, noting, however, that there is no standard approach in relation to sampling procedure, nor to optimal number of panellists (Keeney et al., 2006).

Sample composition. A homogeneous, anonymous panel of five experienced paediatric occupational therapists was engaged for this Delphi process. As Chapter Four's literature review indicated, Delphi research considers homogeneity of panellists important to achieving requisite expertise levels, including homogeneity of professional background and specialisation (Hung et al., 2008; Keeney et al., 2006). In these regards, the original scale

development study had sought the expertise of a diverse professional pool of special educators, paediatric physiotherapists and occupational therapists, and physical education, dance and swim teachers. Consequently, the recommendation of Delphi research not to include random samplings of representative experts, and the context of task-related movement as the expertise requirement, suggested narrowing this sample to a single professional group with expertise classroom-related motor skill development specifically (Hsu & Sandford, 2007; Keeney et al., 2011). This is a domain specialisation of occupational therapy (Case-Smith & O'Brien, 2015; Jackman & Stagnitti, 2007; Royal Children's Hospital Education Unit, 2006; Silverman & Bourke-Taylor, 2009), as noted in Chapter Two's literature review, which outlined their related professional knowledge and training, and their role in classrooms with both students and teachers. Therefore, the inclusion criteria set to ensure this homogenous expertise were:

- recognised occupational therapy qualification,
- 10+ years post-qualification paediatric experience,
- experience that included school-based involvement, and
- willingness and availability for the duration of the study.

Regarding sample size, Chapter Four's literature review noted that while numbers between 3-4 and 3000 have been used for Delphi surveys (Hung et al., 2008; Keeney et al., 2011), smaller samples are appropriate for homogeneous groups, and groups over a certain size cease to improve accuracy (Rowe & Wright, 2001). This was a useful finding in relation to this study, where recruiting large numbers to the right level of expertise presented a challenge. As a professional specialisation area, school-based occupational therapy requires a unique and extensive body of paediatric practice knowledge, as well as knowledge of the educational system, ability to tailor interventions to ensure they are educationally relevant, facility with mentoring and training others (such as teachers and support staff), and well-

developed collaborative skills (Bayona et al., 2006; Laverdure, 2014; Villeneuve, 2009).

Partly because of this, there are not extensive numbers of highly qualified paediatric occupational therapists in Australia. In terms of numbers, in 2014, according to the Australian National Health Workforce Data Set (AIHW, 2014), of 14,000 registered OTs in Australia, 15%, or approximately 2,100 worked in paediatrics, with a significant number of these being newly graduated or in their first years of clinical practice – the existence of a waiting list for paediatric mentors through OTA's MentorLink service (OTA, 2015b) providing further indication of the relatively small pool from which to draw panellists. In considering this, it was decided to seek 5-10 panellists; a number deemed sufficient in the literature for homogenous samples, where generalisability to, and representativeness of the larger group can be more confidently inferred (Broome, Woodring, & O'Connor, 1996; Donohoe & Needham, 2009; Hung et al., 2008; Keeney et al., 2011). This required measures to prevent attrition, which is a concern in Delphi studies where commitment must be maintained across several rounds of work, though notably less of a concern where samples are drawn from particular professions or interest groups, and the sample size is initially small (Cantrill, Sibbald, & Buetow, 1996; Keeney et al., 2011). For this study, the following strategies were adopted to secure retention of panellists for the duration:

- Clear and realistic expectations at the outset as to time requirements for completion of each round and sending of timely reminders and follow-up emails to support ongoing commitment. In terms of time span, panellists were given ten days to complete each round, and the researcher four days to collate responses and return results ahead of the next round. This meant the three-round process took around 42 days,
- Provision of a detailed plain language statement and consent form, and obtaining written consent from each panellist before commencing (see Appendix J),

- Ongoing and responsive email communication throughout the process. Three days before each round was due, panellists were sent a reminder email to ensure timely completion;
- Fitting in with panellist holiday and work schedules; and
- Communicating the value of each member's participation to the research process (Keeney et al., 2011).

Regarding anonymity of panellists, the scholarly literature reviewed in Chapter Four had noted that panellist anonymity supports response rate and consensus building (von der Gracht, 2012), and is particularly important for allied health professions (Atwal & Caldwell, 2005; Parker, 2001), hence, this investigation preserved anonymity through:

- the anonymous nature of the large-scale advertising and recruiting through professional channels and special interest mailings and the discretionary nature of personal invitations,
- the provision to each panellist of a unique link to the survey software,
- de-identification of responses before redistribution ahead of subsequent rounds, and
- use of a formal questionnaire for obtaining opinions.

Regarding geographical location of panellists, paediatric expertise has standard hallmarks and features arising from the development of clinical judgement through experience, hence it was proposed representativeness of the group would be supported regardless of how geographically spread the final pool.

Method of recruitment. Because of the requirement of expertise, panellists were not selected randomly; rather, non-probability sampling techniques, along with the stipulation of meeting inclusion criteria, were used to source expert paediatric practitioners from within the total professional body (Hasson, Keeney, & McKenna, 2000; Keeney et al., 2011). This involved a combination of:

- convenience sampling, dependent on those willing to participate, with a call for panellists placed into two occupational therapy e-bulletins – the local (Victorian) chapter, and the national (Australian) body (see Appendix J – Call for Participants), as well as the Victorian paediatric OT listserv, and verbal invitation made during a seminar presentation on the topic at the OT Victoria and Tasmania (Vic-Tas) annual conference,
- purposive or nominated sampling – gathering interest and making personal invitation at special interest groups and professional development seminars, and
- network, or snowball sampling – signed up panellists advertising through their own networks.

In summary, this e-Delphi survey followed a classic consensus design in relation to setting standards for a classroom measure of motor skill learning, and a non-consensus argument design in relation to identifying formats for reporting results - the latter, a derivative of the process that “focuses on ongoing discussion and seeking relevant arguments rather than focusing on the output” (Keeney et al., 2011, p.6).

Instrumentation

Development of the demographic questionnaire. The use of inclusion criteria had ensured panellists met requirements for participation in terms of a recognised qualification to practice, a minimum of 10 years in paediatric practice, and experience that included working in school settings. The background information that was completed at the commencement of the first Delphi round expanded on this input to support interpretation of unusual responses, or failure to reach consensus. In summary, highest level of occupational therapy qualification, background areas of practice, years of paediatric experience, and graduation year were sought – the last in consideration of the major shifts in rehabilitation thinking that have occurred across the last 40 years (as noted in Chapter Two’s review), possibly

contributing to consensus failure (Carr & Shepherd, 2006; Levac & DeMatteo, 2009; Shumway-Cook & Woollacott, 2012; Zwicker & Harris, 2009). Nature of involvement with students with physical disabilities was also elicited, to ascertain experience directly related to that diagnostic category and to understand the nature of typical involvement for that therapist – whether engaged in the classroom with the classroom teacher, or in a separate space working with the student on their own, or principally in a consultative capacity. As noted in Chapter Two, best-practice now strongly recommends collaborative and in-class approaches to therapy and capacity-development of teachers and teaching assistants to continue the recommendations once therapy has concluded (Chandler & Clark, 2013). Table 18 summarises the demographic information sought.

Table 18 *Demographic Information about Delphi Panellists*

Question	Options
Graduation year	<i>Open field</i>
Highest level of OT qualification	• Diploma • Bachelor's degree • Postgraduate
Years of paediatric OT experience	<i>Open field</i>
Areas of practice	• School • Hospital • Community health • Non-government organisation • Private practice/ consultancy • Other (open field) • Direct intervention with students in or out of the classroom;
Nature of involvement in relation to students with physical disabilities	• Consulting with teachers and support staff; Involvement in teaching, research and writing; • Other (<i>open field</i>)

Development of the survey tool. This section explains the development of the process and the tasks of the survey, and the materials provided to panellists to elicit their responses to the tasks. Table 19 contains an outline of the three rounds of the Delphi survey, with further explanation following.

Table 19 *The Rounds and Tasks of the Delphi Survey*

Considerations	Round 1 - Categorisation	Round 2 – Standard-setting	Round 3 – Reporting formats
Tasks	• Provide demographic details; • Confirm dimensions; • Categorise items	• Confirm the dimensionalised learning continua; • Suggest skills for gaps; • Set cut-scores; • Provide level statements	• Confirm the standards-referenced scale; • Recommend report formats for different audiences/ uses
Materials provided	• Panellist questionnaire; • Five dimensions; • 19 items	• Round 1 consensus; • Ordered item steps in their dimensions; • Standard-setting instructions	• Round 2 consensus; Multi-dimensional, standards-referenced tool; • Report format options
Analysis of results	• Collate panellist information; • Summarise items into dimensions; • Calculate percentage consensus	• Finalise standards; • Collate comments and suggestions	• Consolidate results re tool and reporting format recommendations; • Table all comments and suggestions
Reporting back	• Consensus level achieved; • Amendments in response to suggestions	• Results of standard-setting; • Amendments in response to suggestions	• Thanks, and summary of work

Rounds. Determination of the number of rounds considered the three-round recommendation of many studies, as noted in Chapter Four's literature review, as being generally sufficient to collect needed information and reach consensus (Hsu & Sandford,

2007; Keeney et al., 2006; Trevelyan & Robinson, 2015). This number was also deemed appropriate in relation to the number and nature of the decisions to be made, and the logistic factor of time and availability of panellists. Consequently, the decision was to structure a three-round survey, with an option of a fourth round tabled with panellists at the outset, in the case of outstanding consensus issues. Between rounds the researcher's role was to collate and review responses, summarise opinions, note level of consensus as well as individual concerns, make modifications to the working document in line with recommendations, and send these out again for further comment and refinement.

Tasks and materials. As noted in Chapter Four, the Delphi process involves retrospective and prospective work across rounds, as panellists work towards consensus of prior proposals and give their opinions on further aspects (Kleynen et al, 2013).

Round 1. Regarding the tasks of the first round, where analysis of scholarly opinion has already established grounding for an opening proposal, a common modification of the open-ended question that begins the work is a structured question from the research and opportunity for panellists to confirm this, ahead of engaging in new constructive work (De Villiers, De Villiers, & Kent, 2005; Hsu & Sandford, 2007). Consequently, it was determined that the first round would involve a retrospective confirmation that the five aspects, or dimensions proposed from the literature adequately comprehended the domain of class-room related motor skill, and a prospective task of placing the 19 items into these dimensions according to panellist understanding. To achieve this work, panellists were provided with a summary of the literature review via Tables 7 and 8 of Chapter Three, showing the various categorisations of different major proponents tabulated to the five-dimensional proposal, and a rationale stating that while all the items pertained to a unidimensional construct, sub-dimensions were often used to assist interpretation of results and targeted intervention, as providing more detail of student strengths and learning needs.

In addition, examination of a range of standard clinical tools and motor classifications in the literature had revealed five broad aspects commonly used in categorisation of the domain, as reflected in the table. Therefore, panellists were invited to select one or more of these sub-dimensions for each of the 19 items, in a process of back translation, using the matrix design questionnaire provided in SurveyMonkey™, and to indicate in the open-comment fields following, any difficulties of placement, use of multiple aspects for an item, usefulness of these divisions of the domain, and suggested alternatives. This provided further strong indication of content validity for the instrument. Figure 18 provides an excerpt of how this categorisation task appeared in SurveyMonkey™ (all the materials of Round 1 are provided in Appendix M: Study 2 Delphi Materials).

Instructions: Place the 19 skills as you feel they best fit into these five categories.

PLEASE NOTE: Provision has been made for you to choose more than one category if you are divided in your opinion about best placement of a skill.

Use the questions following this task to provide your reasoning for any issues encountered, concerns about the categories or their labelling, and possible alternatives, or other suggestions.

	Balance, postural control and positioning	Transportation of self and objects	Manipulation and use of school-related objects, tools and equipment	Self-regulation, self- expression and social interaction	Fitness, endurance and motivation
Maintaining balance and upright posture	☐	☐	☐	☐	☐
Regulating physical tension (self-regulation)	☐	☐	☐	☐	☐
Coordinating response to sensory input	☐	☐	☐	☐	☐
Positioning self to engage in activity	☐	☐	☐	☐	☐
Remembering a movement sequence or strategy	☐	☐	☐	☐	☐
Moving from one position or place to another	☐	☐	☐	☐	☐

Figure 18. Extract of the skills categorisation exercise for Delphi Round 1

Round 2. This round began with a summary of the level of consensus achieved in Round One with regards to the categorisation of the 19 skills, and opportunity for further consideration of responses where the consensus level had not been reached. Following this,

the standard-setting work following Bookmark methodology took place via completion of four tasks –

1. Skill ordering in the aspects. Panellists were provided with the items categorised together according to Round One's consensus, broken out to their item proficiency steps, and asked to confirm or change the order of items as seemed correct to them. Note that previous calibration using partial credit item response modelling had empirically ordered these steps by difficulty. Panellist were asked to confirm this order, enabling expert opinion and empirical results to be compared as further verification of the construct's validity (Wright & Stone, 1979).
2. Additional item suggestions for perceived gaps. Panellists were encouraged to note any gaps and suggest skills to fill them, in keeping with Bookmark methodology provisos that "ordered item booklets" (OIBs) can include items that have not been part of previous testing (Cizek & Bunch, 2007, p.7). While additional items are generally exported from item banks with their difficulty indices known, enabling accurate placement on the progression, in the current study, placement suggestions made in Round 2 formed part of the deliberations in the subsequent round.
3. Setting cut points where panellists considered significant skill advances had occurred. Lewis et al (2012) explain this evolution of the Bookmark procedure, whereby panellists categorise which items belong to broader performance bands or levels, establishing "mastery and non-mastery zones for each cut score in the OIB" (p. 232).
4. Providing skill summaries for each division. These "performance level descriptors" express the kinds of knowledge, skills, and abilities operating at each level, communicating the nature of the increasing skill as both goal and description (Lewis et al., p. 236) (see Appendix M for all Delphi panel materials).

Round 3. This round provided panellists with a composite summary of the standard-setting work completed in Round Two for further consideration and requested consideration of three different options for reporting results, using a student assessed during the first study.

These were –

1. Reporting at the single, or ‘gist’ level: A unidimensional report, divided into learning stages, with a black line indicating level of current performance – see Figure 19.

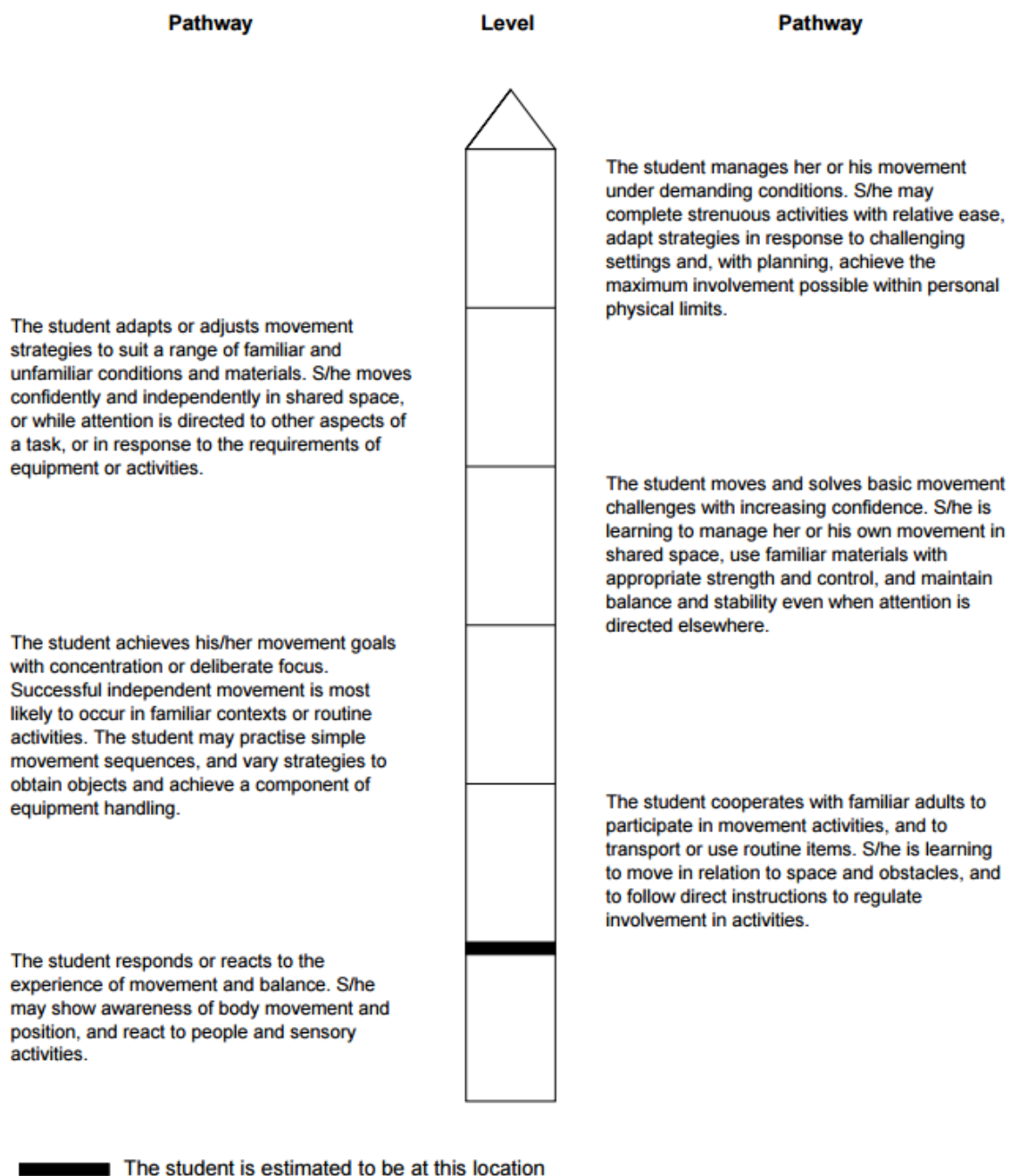


Figure 19. Single dimension report (Griffin, 1995, p.108)

Reporting at this level followed assumptions of unidimensional construct measurement: that for highly correlated items, only a single score is needed (Adams et al., 1997).

2. Reporting at the level of sub-aspects, according to multidimensional item response modelling (MIRM) (Adams et al., 1997): Five aspects, each standardised into performance levels (i.e. from the findings of Rounds 1 and 2), with the red text indicating the student's current capacities, and the green highlighted cells indicating the focus of intervention for the next stage of work – see Figure 20 for a 2-dimension excerpt – provided in full in Appendix M.

1. Balance, postural control, and positioning	2. Transportation of self & objects
	LEVEL 5: The student transports self and/or objects effortlessly and fluently within diverse and dynamically changing environments; he/she achieves multiple additional activity goals concurrently, requiring cognitive attention and dynamic adjustment to unfolding/ unpredictable situations
LEVEL 4: The student smoothly adjusts and readjusts body position to maintain dynamic balance during movement activities, or in response to changing activity requirements. He/she automatically applies a range of strategies to maintain or regain balance and stability in unpredictable or dynamically changing situations	LEVEL 4: The student applies problem-solving skills in response to unexpected task/activity requirements, to continue to safely achieve transport goals. He/she successfully transports objects in more complex, or non-routine tasks. Repetition and practice results in increasingly successful outcomes in terms of efficiency and speed
LEVEL 3: The student adjusts/ corrects posture and position for optimal task engagement, and responsively corrects lost seated balance if knocked. In mobilising, he/she can maintain balance with attention directed elsewhere	LEVEL 3: The student achieves independent transport of self/objects in routine tasks slowly, with concentration, or in response to modelling/ instruction. He/she engages in practice and/or refining of transport sequences/skills. The focus continues to be on the movement, rather other aspects of the learning activity
LEVEL 2: The student draws on external cues (physical or verbal) to actively position self and commence activity, and with concentration, can maintain balance and postural control at selected times or during static/ table tasks and activities	LEVEL 2: The student responds to, and actively cooperates/ participates with support in routine learning tasks and activities involving transport of self and objects/ items. He/she undertakes components of transport tasks as able, and moves in anticipation of and response to transport components of tasks and activities
LEVEL 1: The student attempts to maintain upright head position in seated position and makes reflexive/sensory responses to lost balance. With support to achieve initial posture, he/she engages in learning activities placed before him/her, relying on direct, ongoing support (e.g., supported seating, positioning aids and modifications)	LEVEL 1: The student passively experiences and responds to sensory aspects of objects/ movement. He/she relies on adult support, and direct assistance to achieve transport goals

The student is estimated to be performing at these levels; Focus of the next stage of learning

Figure 20. Dimensional category report (2-dimension excerpt)

The goal of multidimensional item response theory (MIRT) is to report on student performance from more than one perspective, increasing the amount of useful information extracted from test results to guide differentiated instruction for individual students (Adams et al., 1997; Egan et al., 2012; Wu & Adams, 2006). MIRT provides meaningful sub-scores for performance on unidimensional sets of items, producing an ability profile for a student rather than a single score (Hartig & Hohler, 2009).

3. Reporting at the single item level: 19 items, grouped into the five aspects, with the student's score for each item provided – see Figure 21 for an excerpt – in full in Appendix M.

CATEGORY 1 - Balance, postural control and positioning	
1 Maintaining balance and upright posture (seated or standing)	
☐	0 Is moving towards but has not yet achieved this skill
☒	1 Reacts to lost balance (e.g., startles; rights head; extends arms)
☐	2 Relies on strategies or cues to maintain stable posture (e.g., "feet flat, bottom back to sit up straight")
☐	3 Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)
☐	4 Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)
4 Positioning self to engage in activity	
☐	0 Is moving towards but has not yet achieved this skill
☒	1 Responds to activity when positioned in front of it (e.g., shows interest; attempts to reach)
☐	2 Assists in being positioned for activity engagement (e.g., leans/ moves in)
☐	3 Positions self to commence activity (e.g., moves into position to enable use of objects/ tools)
☐	4 Anticipates and adjusts position throughout activity to support efficient functioning

Figure 21. Excerpt of a single item report

A final report-back, summarising the results, completed the Delphi study.

Data Collection

The online survey utilised SurveyMonkey™ software for survey development, email communication with panellists, and data collection. To commence the survey, panellists were sent a separate SurveyMonkey™ link to the demographic questions and the work of Round 1. This included an email with background information about the work of each round and the Delphi process, in which turnaround times, envisaged length of time to complete each round and support for timely completion of responses were set out. Panellists clicked on the link in the email to open the survey and complete their responses, at the conclusion of which they uploaded their results, which were then immediately accessible by the researcher. Turnaround times for panellists to complete the work of each round was 10 days, and the time allocation for the researcher to complete the between-round work and return results back to the panellists to begin the next round was 5 days.

Ethical considerations. The Delphi methodology preserved anonymity of Delphi members to one another (though not to the researcher) via its online, individual nature, hence this was a minimal risk study. Ethics approval for recruiting and engaging with occupational therapists was granted from the Human Research and Ethics Committee of the Melbourne Graduate School of Education, the University of Melbourne, via an amendment to Study 1's ethics approval, and from Occupational Therapy Australia (see Appendix K for approvals).

Data Analysis

In a Delphi process, data is analysed by the researcher, and conclusions drawn provisionally into proposals for the next round of consensus-building. The consensus goals of the Delphi panel pertained to categorisation of items into dimensions and establishing of standards for each of the scales. Regarding consensus, in light of Chapter Four's recognition of different perspectives on consensus, this investigation focused on convergence of opinion (Hsu & Sandford, 2007), and also reasoned that as this study involved setting standards for a

movement capability assessment that could conceivably be used to make decisions around support provisions, the statistical level of consensus should be pre-set at 75% – the minimal level identified by Keeney et al.'s (2006) decade-long of use of the technique across a variety of applications.

Categorisation of items involved a matrix design questionnaire and open fields for further comments. This was a structured task, and data analysis involved tabulation of responses and calculation of percentage agreement of all options. Open-field comments were collated and suggestions relating to the consensus work were passed back to panellists to support consensus-building in the next round.

Setting standards involved completion of two main tasks – firstly, dividing the continua of each of the dimensions where significant 'shifts' in the nature or sophistication of the skill were noted, and secondly, briefly summarising the nature of the skills operating at each level. A third aspect for optional response was to note perceived gaps and make suggestions for filling them. Data analysis for the two main tasks involved tabling the level considerations to determine those with majority agreement and any minority opinions that might also support further deliberation and collating the level descriptions and producing a synthesis for further comment and refinement. Suggestions of additional items for gaps were tabled and inserted into the continua at the points suggested, and this work was passed back to panellists for consideration in the third round.

The non-consensus goal was to gather expert opinion about three possible reporting formats for the scale in relation to report purposes and the needs of different stakeholders involved in the student's classroom learning. This was a structured question involving a checkbox-type response, where panellists could choose more than one option. The first question asked the best report type for different target groups, with seven target groups listed as possibilities, and the second question asked the most appropriate purpose for each report

type, with five possibilities provided. Data analysis involved tabulating responses and calculating the percentages of each response. Figure 22 provides an excerpt as it appeared in SurveyMonkey™.

2. For each of the following purposes, which type of report is most appropriate? 

	Gist level report (reporting on 1 dimension)	Categories report (reporting on 5 skill categories)	Itemised test (reporting on 19 items)
Screening/ summary	☐	☐	☐
Planning/ goal-setting	☐	☐	☐
Baseline/ interim monitoring/ outcome measure	☐	☐	☐
Accompanying funding/ other applications/ justifying aide time	☐	☐	☐
Educating teachers/ aides/ new therapists	☐	☐	☐

Other (please specify)

Done - Thank you!

Figure 22. Excerpt of Delphi Round 3 work – establishing report-type for purpose

At the commencement of each round, items for further consensus deliberation were listed as itemised points with a four-point Likert-type scale provided for response (agree strongly – agree – disagree – disagree strongly), which was then scored dichotomously to ascertain consensus extent. Figure 23 provides an example of how this appeared in SurveyMonkey™, and Table 20 summarises the questions asked, and data analysis method used in each case.

Please indicate your level of support for these changes and the consensus reached so far. 

	Agree strongly	Agree	Disagree	Disagree strongly
Cut points	☐	☐	☐	☐
Other (please specify)				
Level statements	☐	☐	☐	☐
Other (please specify)				

Figure 23. Depiction of Likert-type options supporting consensus-building

Table 20 *Delphi Survey Tasks, Eliciting Questions, and Data Analysis Methods*

Task	Question-type to elicit responses	Method used to analyse responses
<i>Round 1:</i> Categorisation of items	Matrix-design questionnaire allowing multiple option choice Open fields for further comments	Tabulation of responses Calculation of percentage agreement Collation of open-field comments
<i>Round 2:</i> Standard-setting cut-points	Appended document with continua in their dimensions and instructions for setting cut-points and constructing level statements	Tabulation of decisions as majority perspectives and significant minority alternatives
<i>Round 2:</i> Standard-setting – level statements		Collating descriptions and producing a synthesis
<i>Round 3:</i> Reporting formats for different purposes and stakeholders	Open-ended question to establish purposes and stakeholder groups, followed by structured checkbox type questionnaire allowing multiple option choice	Tabulation of responses Calculation of percentage agreement
<i>All rounds:</i> Processes for achieving further consensus	4-point Likert-type rating scale for signifying level of agreement/ disagreement	Dichotomous scoring of rating scale (agree/disagree)

The researcher as moderator was responsible for all between-round work, involving collating and studying responses, summarising group opinions, establishing levels of consensus, modifying the working document in line with recommendations, responding to individual concerns, and sending out the work for the next round in a timely manner.

Summary of Study 2

This section has described the methodology of Study 2, in which the goal was to work with experienced paediatric occupational therapists using Bookmark methodology to set standards for the dimensionalised scale of Study 1, as well as identify, in response to the second research question, reporting formats for different stakeholder groups.

Study 1 and 2 – Relationship of Student Information to Scale Performance

As noted in the first section of this chapter, Study 1's demographic questions included information on impairment severity and bodily location of functional difficulties in assessed students. Separately, Study 2's standard-setting work for the five dimensions enabled score ranges to be allocated to each of the levels of the derived progressions, making it possible to locate students by ability into one of these broader, instructionally useful bands. The process involved recoding the weighted likelihood estimate of ability (WLE) equivalence scores for each of the dimensions into the levels, by attending to the threshold scores for the item proficiency steps above and below each cut-point that had been substantively set by the Delphi panel. With these score ranges allocated, a cross-tabulation (contingency table analysis) using SPSS statistical software was possible (IBM Corporation, 2016), in response to propositions undergirding the final research question that student characteristics (impairment severity, bodily location) would impact scale performance.

In relation to this investigation, to establish the strength of association, student results for the sub-categories of impairment severity were cross-tabulated against performance on the levels of the five dimensions, and student results for the sub-categories of upper- and lower-body impairment were cross-tabulated against the same performance levels. As to the latter aspect, those with difficulties using their arms/fingers or achieving functional gripping were combined to form the upper-body impacted group, and those with difficulties using their

legs/feet formed the lower-body impacted group. The null hypothesis of independence was that actual results would reflect chance only, or expected scores (Argyrous, 2011).

To establish the presence or otherwise of a relationship, a Pearson chi-square test for independence was undertaken, as the descriptive statistic was a crosstabulation of two or more independent samples, and the expected frequencies were sufficiently large (none less than 1, and no more than 20% less than 5) (Argyrous, 2011; Michael, 2008). SPSS software calculated the probability of the *actual* distribution of scores against an infinite number of *random* samplings. The output produced an expected score for each category on the basis of the null hypothesis being true, and an overall chi-square statistic establishing strength of relationship. Actual scores for each category were compared to expected scores, and adjusted residual scores derived, providing indication of those categories contributing most to the chi-square's statistical significance level. Reference to the table of critical chi-square values determined whether the statistic was of sufficient size to reject the null hypothesis (Knoke, Bohrnstedt, & Mee, 2002). This matrix of scores plotted degrees of freedom (*df*) in the data (the number of different categories used to calculate the statistic) against the possible levels of significance (α) – the most stringent being 1 in 1000, or 0.001 probability that the outcome was the result of chance alone. To uphold the null hypothesis, the residuals, having a mean of 0 and standard deviation of 1, would show scores less than 2 or greater than -2. To reject the null hypothesis, the residuals would be either greater than 2, or less than -2, and a relationship between the variables would be presumed, though as Argyrous (2011) notes, its nature would not thereby be known.

In summary, SPSS software was used to produce a chi-square index of association, or strength of relationship between scale performance and independent variables of impairment severity and impairment location, which the literature review had flagged as likely to influence results. Standardised residuals, indicating which pieces of data had most influenced

or contributed to that outcome, were calculated. The two categorical variables were cross-tabulated against the standards of the five dimensions, and adjusted residuals and chi-square statistics examined, to establish the existence and strength of relationship between these variables and respond to the final research question.

Chapter Six: Study 1 (Trial) Results

This chapter presents the results of the first stage of Study 1, which trialled the draft set of classroom movement indicators with students from a wide range of disability backgrounds.

The goal of this trial was to establish, in response to the first research question,

*... the typical developmental learning progression of goal-directed movement
for students with motor performance needs.*

The inclusion of students from all disability backgrounds at this stage was to ensure all skills across the scale were calibrated, and the item pool was invariant for the target group. In this chapter, following a combined demographic report of both trial and data-collection participants, the results of the trial are reported and response to the first research question is made.

Determining an Invariant Pool of Items

Demographic Characteristics of Trial and Main Study Participants

Common background questions were used for both the trial and main study of Study 1, to elicit information about schools, assessors, and students. In the next section, these results are reported together, before reporting the calibration results of the trial item pool.

Schools. 61 Australian schools participated in the 2015 trial, of which 53 schools participated in the 2016 main study – the reduced number due to the main study’s focus on students with motor performance needs only. In both cases, special education schools represented all metropolitan and regional centres of the state and included those catering for students with physical disability, intellectual disability, autism, and hearing impairment.

Table 21 provides the number participating for each type of school.

Table 21 *Type of Schools Involved in the Trial (n=61) and Main Study (n=53)*

School type:	2015 Trial No. (%)	2016 Main Study No. (%)
Special (intellectual disability)	42 (69)	36 (68)
Physical disability specialist	4 (6.5)	3 (5.5)
Mainstream (primary/ secondary)	8 (13)	7 (13)
Autism specialist	5 (8)	5 (9.5)
Deaf specialist	2 (3.5)	2 (4)
<i>Total:</i>	<i>61 (100)</i>	<i>53 (100)</i>

Assessors. The trial involved 328 assessors, and the main study 219. Table 22 sets out their demographic characteristics, and Table 23 their years of experience.

Table 22 *School Roles of Assessors in the Trial (n=328) and Main Study (n=219)*

Roles	2015 Trial No. (%)	2016 Main Study No. (%)
Classroom teachers	300 (91.5)	187 (85.5)
Special education coordinators	8 (2.5)	8 (3.5)
Movement teachers (PE, aquatics, dance)	5 (1.5)	12 (5.5)
Other (e.g., health professionals; teaching support staff)	15 (4.5)	12 (5.5)
<i>Total:</i>	<i>328 (100)</i>	<i>219 (100)</i>

Table 23 *Years of Special Education Experience of Assessors*

Experience (yrs.)	2015 Trial No. (%)	2016 Main Study No. (%)
0-2	92 (28)	57 (26)
3-10	102 (31)	88 (40)
10+	134 (41)	74 (34)
<i>Total:</i>	<i>328 (100)</i>	<i>219 (100)</i>

A large proportion of assessors had over ten years of teaching or school-based experience with students from a range of disability backgrounds, a level of expertise not typical of the wider teaching profession (VEOHRC, 2012) but reflecting the study's intentional targeting of special schools and their educators to ensure sufficient numbers of appropriate students were assessed for purposes of instrument calibration.

A question about familiarity with the student established that most assessors (60%) had a minimum of 6 months' knowledge of the student they assessed, consistent with the time of year when the assessments took place, and a significant minority (28%) had over a year – see Table 24. This established the credibility of their observations.

Table 24 Assessor Familiarity with Students (n=1352)

Time knowing the student	No. (%)
Less than 3 months	80 (5.9)
3 to 6 months	87 (6.4)
6 to 12 months	806 (59.6)
1 to 2 years	284 (21)
Over 2 years	95 (7)
<i>Total:</i>	<i>1352 (100)</i>

Students. The trial involved 1352 students, and the main study 650, with the majority (over 95%) coming from participating special schools. Table 25 sets out the gender, age, and disability diagnoses of the student pool for both trial and main study. The average age was 11 years in both cases, and standard deviation 3.6 years for the trial study and 3.9 years for the main study.

Table 25 *Student Characteristics for the Trial (n=1352) and Main Study (n=650)*

Aspect	2015 Pilot No. (%)	2016 Main Study No. (%)
<i>Gender:</i>		
Boys	947 (70)	422 (65)
Girls	405 (30)	228 (35)
<i>Total:</i>	<i>1352 (100)</i>	<i>650 (100)</i>
<i>Age range:</i>		
4-7	293 (22.5)	143 (22)
8-10	338 (25)	163 (25)
11-13	329 (24.5)	143 (22)
14-16	285 (21)	123 (19)
17+	106 (7.5)	78 (12)
<i>Total:</i>	<i>1352 (100)</i>	<i>650 (100)</i>
<i>Disability type:</i>		
Physical disability	305 (22.5)	267 (41)
ASD	675 (50)	283 (44)
Intellectual disability	1009 (74.5)	527 (81)
Vision impairment	160 (12)	117 (18)
Behaviour disorder	131 (9.5)	111 (7)
Hearing impairment	105 (8)	51 (8)
Language impairment, educational need	426 (31.5)	340 (52)

More than one diagnosis could be nominated for each student, and the results show the prevalence of multiple diagnoses, confirming research findings that most individuals with a disability live with more than one condition (Bruhn, 2011). Table 26 shows the frequency of conditions co-occurring with physical disability (PD) in both trial (PD=305) and main study (PD=267).

Table 26 *Conditions Co-occurring with Physical Disability*

Co-occurring conditions	2015 Trial No. (%) of 305	2016 Main Study No. (%) of 267
ASD	42 (14)	40 (15)
Intellectual disability	281 (92)	245 (92)
Vision impairment	98 (32)	85 (32)
Hearing impairment	35 (11.5)	32 (12)
Language impairment, educational need	150 (49)	189 (71)
Behaviour disorder	13 (4)	40 (15)
<i>Total:</i>	<i>305 (100)</i>	<i>267 (100)</i>

While the seven categories listed in Table 26 were selected because of their familiarity to Australian teachers through making disability funding applications, aligning motor impairment to physical disability diagnoses did not reflect the findings of Chapter Two that motor impairments arise from many conditions (ABS, 2015). Nor did it enable categorisation of severity and type of classroom impact, expressed at the mild end for example, in the following ad hoc comments made of some of the 633 students with ASD but no physical disability, who were assessed for the trial:

“some underdeveloped skills, such as drawing/writing”,

“motor planning issues”,

“some fine motor difficulties”,

“difficulties appear to be from low tone and/or learned helplessness”,

“sensory overload issues – can become highly stimulated and unable to regulate”,

“needs to concentrate; needs to slow down”,

“coordination difficulties occasionally in motor processing”,

“has a very weak core, tends to slouch”, and

“has no mobility issues but is developmentally behind neuro-typical peers”.

Therefore, in the main study, information was also sought about assistance requirements (to establish impairment severity) and location of disability (to establish likely classroom functioning impact). Table 27 sets out the results of these demographics questions, indicating students were evenly spread across the options.

Table 27 *Additional Physical Features of Assessed Students in Main Study (n=650)*

Additional student features	No. (%)
<i>Level of assistance required:</i>	
Extensive help or supervision	160 (24.5)
Aids, cues, prompts	176 (27.1)
Independent, but difficulty with extended tasks	154 (23.5)
No assistance requirements	126 (19.5)
<i>Location of disability:</i>	
Arms, fingers	200 (31)
Gripping things	281 (43)
Legs, feet	228 (35)
Medical condition(s) causing generalised restriction	245 (38)
<i>Total:</i>	<i>650 (100)</i>

Having reported the demographic characteristics of the trial and main study participants of Study 1, the next section addresses the first research question – the presence of a learning progression and considers the extent of item invariance for students with physical disability. This will involve reporting, firstly, the trial’s scale reliability, item parameter estimates, and item difficulty estimates, followed by conducting an individual item review where invariance will be considered.

Statistical Analysis of Trial Results

An IRT analysis for items scored in a partial credit fashion was conducted on the trial data (Masters, 1982). Data analysis considered the extent to which the items separated successfully along the variable (Wright & Masters, 1982), and whether this progression of skills was meaningful, mapped to the hypothesized construct and its underpinning theoretical base, was internally consistent, and spread students by ability along the scale (see Chapter Five). Traditional statistical analysis revealed an alpha reliability of 0.97, indicating a high degree of internal consistency for the items, and a strongly unidimensional scale, and an overall item separation reliability of 0.99, indicating items well separated in terms of stringency (Wright & Stone, 1979). Person separation reliability was 0.95, indicating students were well separated along the scale by ability. Table 28 presents the parameter difficulty estimates, standard errors, item-rest correlations, and fit values. The first two columns refer to the item number and description. The next two columns (δ_i and Error) refer to item difficulty parameters. Standard errors were small – between 0.06 and 0.08, reflecting the large sample size in relation to the number of items (Wilson, 2005). The item-rest correlations or discrimination indices were also good, evidenced by their closeness to 1, expressing the fact that performance on individual items correlated positively with overall test performance (Wright, 1995a; Wu & Adams, 2007). IRT calculates standard errors of measurement for items, providing an interval around the stated location within which the actual item can be more precisely located (Wright, 1995a). The final column reports the weighted (infit) mean square – the difference between the estimated and observed difficulty of each item.

Table 28 *Parameter Estimates for the Trial Items*

Item (number and description)	Difficulty Estimate (δ_i)	Error	Item- Rest Cor.	Infit WMNSQ
1. Maintains balance and upright posture	-0.62	0.05	0.76	1.58
2. Regulates physical tension	0.18	0.06	0.74	1.25
3. Coordinates response to sensory input	-0.30	0.06	0.86	0.92
4. Positions for activity	-0.48	0.05	0.85	0.97
5. Remembers a movement sequence	0.1	0.05	0.85	0.87
6. Moves from position/place to another	-0.27	0.05	0.85	1.02
7. Avoids obstacles	-0.39	0.05	0.81	1.03
8. Uses sporting or activity equipment	-0.17	0.06	0.86	0.82
9. Transports objects from place to place	0.14	0.05	0.85	0.85
10. Manages personal school equipment	-0.89	0.06	0.83	0.88
11. Manipulates and uses tools and materials	-0.04	0.06	0.84	0.89
12. Shares space interactively	-0.28	0.06	0.79	1.06
13. Moves for self-expression/ communication	0.28	0.05	0.76	1.23
14. Perseveres in movement tasks or activities	0.47	0.05	0.87	0.82
15. Works within physical limits	1.15	0.05	0.81	0.94
16. Completes tasks involving strenuous effort	1.14	0.04	0.84	1.14

Of the 16 items, 15 demonstrated a good fit to the Rasch (1980) model. Item 1 demonstrated underfit by its weighted mean square value of 1.58 (indicated in bold in the table), which is outside the recommended 30% variance of -0.75 to 1.33 (Adams & Khoo, 1996; Wright & Masters, 1982). This item was flagged for expert review, which would include a DIF analysis to determine the extent to which this may have been a factor in its poor performance.

While there were no fit problems with other items, the requirement that each item meet the expectation of increasing difficulty of item proficiency steps was not achieved for Item 6, which showed “category disordering” of its second and third steps (Wu & Adams, 2007,

p.64), with under-selection of the second step implying the third step was easier. Therefore, this item was also tabled for expert consideration ahead of the main study.

Finally, though well-fitting, item-steps 5.3 and 10.3 were also tabled for review, to discuss possible inconsistencies between their descriptions and derived difficulty levels. Following reporting of item difficulty and person ability estimates for the scale, the observations made about these items are first summarised, followed by a report of recommendations.

Item Difficulty and Person Ability Estimates. Estimates of item-threshold difficulty and person ability were modelled on the same vertical axis, enabling students to be placed adjacent to items whose level of difficulty matched their level of ability. Figure 24 provides this item-threshold map. On this map, the numbers on the far left represent the logit scores, indicating the difficulty levels of items, and, simultaneously, the ability levels of students whose probability of achieving those scores or higher reached 0.50. The mean difficulty of the scale, set by default to 0, enables items to be placed relative to the point delineating their degree of difficulty. Each 'X' on the map represents 3.6 individual students. The numbers in the right-hand column are the steps of the items, placed relative to their logit difficulty.

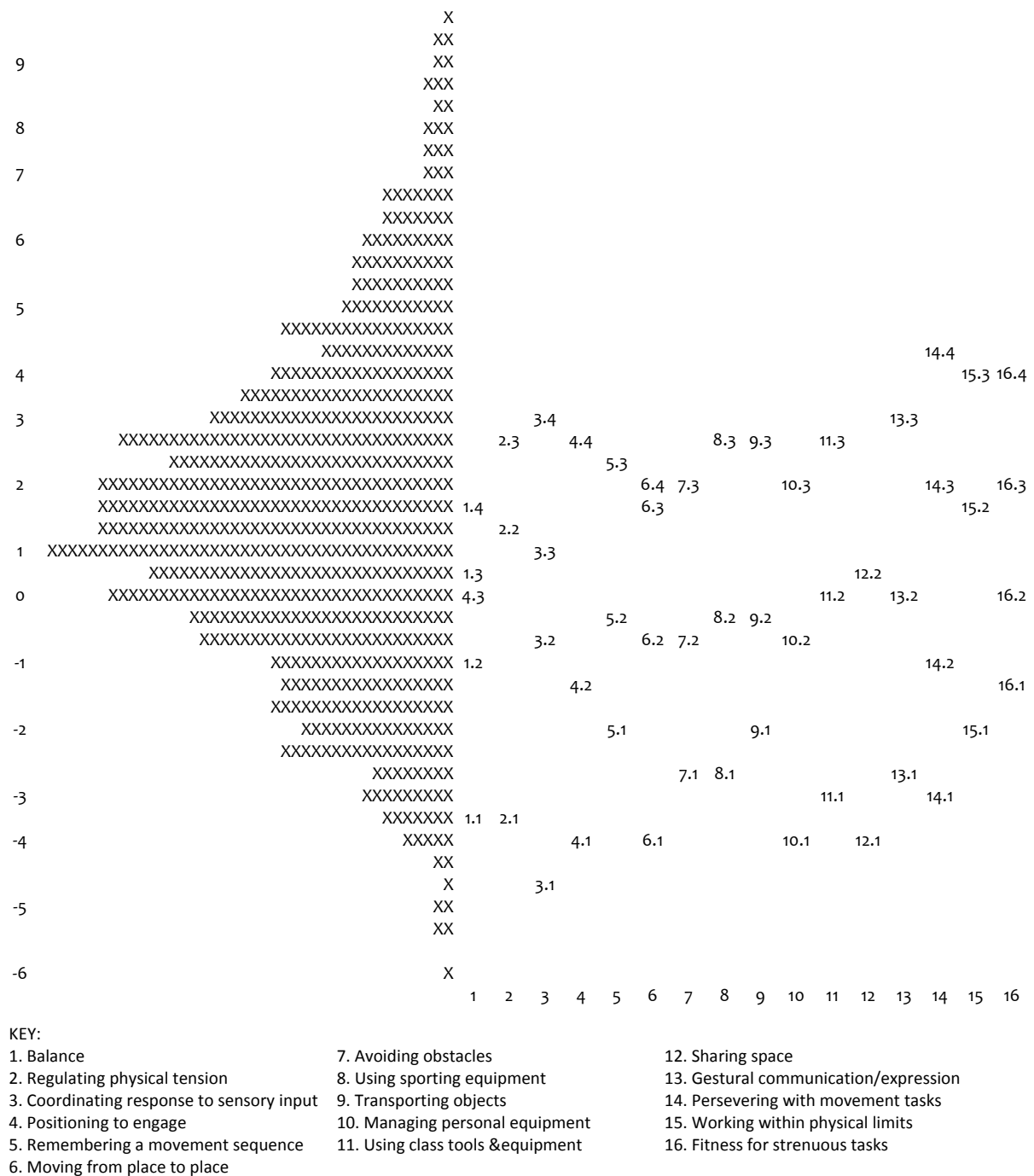


Figure 24. Item-threshold map of the trial items

Figure 24's item-threshold map indicates that, at -4.49 logits, the easiest option is 3.1 – “Attends to the sensory aspects of objects or environment”, providing for this measure a baseline that all students are most likely to reach. At the other end of the scale, item 14.4 – “Adapts movement strategies in response to more challenging settings” has a difficulty of

4.04 logits and is less achievable for most students. In between these parameters, the remaining items are spread in order of increasing movement demand.

The visual nature of the map enables an initial assessment of test difficulty – here showing that the set of items matched well to the abilities of students working at beginning stages, so that very few students failed to achieve a score. However, the skill demand of the instrument has not adequately captured the abilities of 110 students who achieved the top score of 54. In their case, ability in the construct remains unknown, suggesting a need for harder items. As this calibration included results from students without physical disability, a query regarding these top-performing students was whether they constituted the non-physically disabled group only, which might suggest lack of invariance of the item pool for the target group. Determining this was complicated by the fact, already noted, that motor impairments accompany a range of conditions other than physical disability. Two analyses were undertaken; firstly, an inspection of the data, which revealed that seven students from the top performing group had physical disability diagnoses and, via the optional open comments field, a further student had impacted motor functioning, according to the following remark: *“Hand-eye coordination poor, has difficulty forming letters and numbers particularly those that involve direction change.”* Secondly, a comparison of the model item parameters obtained from the partial credit IRT analysis (Masters, 1982), against those for the 305 students with physical disability, was conducted. Figure 25 provides the bi-variate plots graph depicting the results of this analysis:

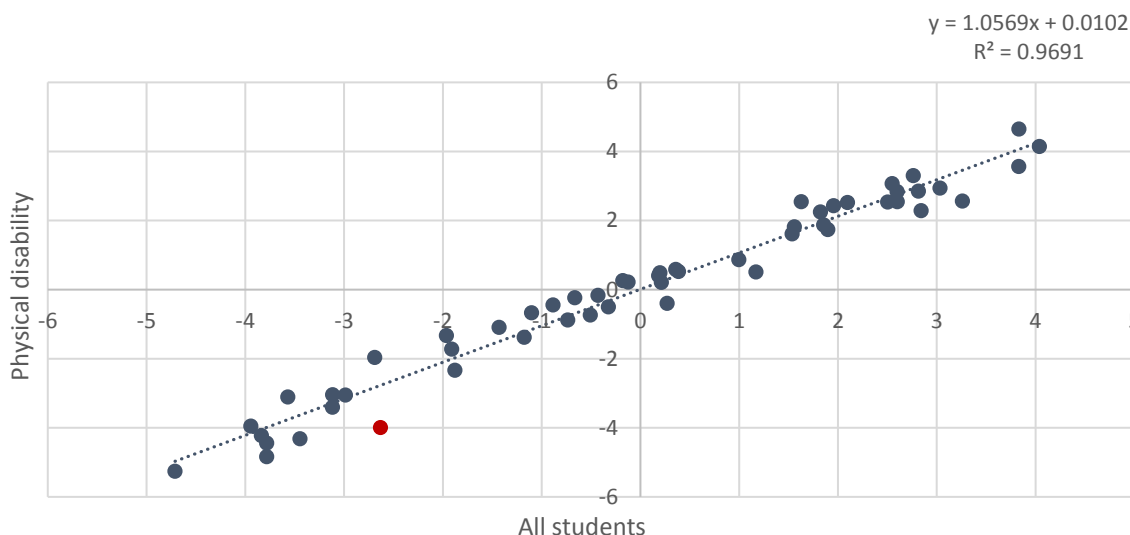


Figure 25. Bivariate plots of delta difficulty estimates (physical disability vs. all students)

If items function in an invariant way for sub-groups of a total population, the bi-variate plot is linear, the slope statistic is near 1, and the scatter of item-steps around the trendline reflects standard errors only (Hambleton, Swaminathan, & Rogers, 1991). Figure 25 demonstrates that the slope of the line of best fit is very near 1, and the correlation (R^2) between the two parameter sets is high (0.969), indicating there is significant similarity in the way goal-directed movement skill develops for the cohort with physical disability, compared to that of the whole group. The 54 item-steps (represented by the dots) also show good alignment to the trendline of best fit, with absolute values not significantly greater than 1 for item-steps other than 13.1 (indicated by the red dot on the graph), which returned an absolute value difference of 1.364. This item concerned moving for self-expression and communication, with the first step concerning achievement of gestural communication interpretable by familiar others. While it was easier than expected for students with physical disability to achieve this step, as it drew on the receptive communication skills of the communication partner, this was considered unsurprising, and the effect of this difference on performance overall negligible.

The next section of this chapter will continue discussing DIF, as part of discussion of item review decisions by the expert panel.

Individual Item Review. The review panel consisted of 15 subject matter experts, including a person with lived experience of physical disability, as well as experienced special educators, physical education specialists, physiotherapists, and occupational therapists. Thirteen schools were represented by this group, including all four physical disability special schools, one mainstream P-12 College, two Autism special schools, and five schools for intellectual disability. In addition, the group included two academics with educational measurement expertise from the University of Melbourne, and a representative from the Victorian DET. As previously noted, the items tabled for consideration by this group were Item 1, due to misfit, Item 6, due to disordered delta difficulty estimates, and item-steps 5.3 and 10.3, due to anomalous wording to their derived placements. The group's observations will be summarised first, followed by their interpretation and recommended renovations.

Item 1 – *Maintains balance and upright posture.* While the Item-Total Correlation of 0.80 indicated this item aligned well with the overall test (Wu & Adams, 2007), the high weighted mean square (WMNSQ) fit statistic of 1.58 indicated almost 60% of participant assessors rated students unexpectedly, so the item had reduced discriminating ability (Adams & Wu, 2010). At the step level, the fit statistics were highest for Steps 1 (infit 1.22), and 4 (infit 1.3), indicating greatest randomness for those scores. Figure 26 depicts the item's performance as an expected score curve (ECC).

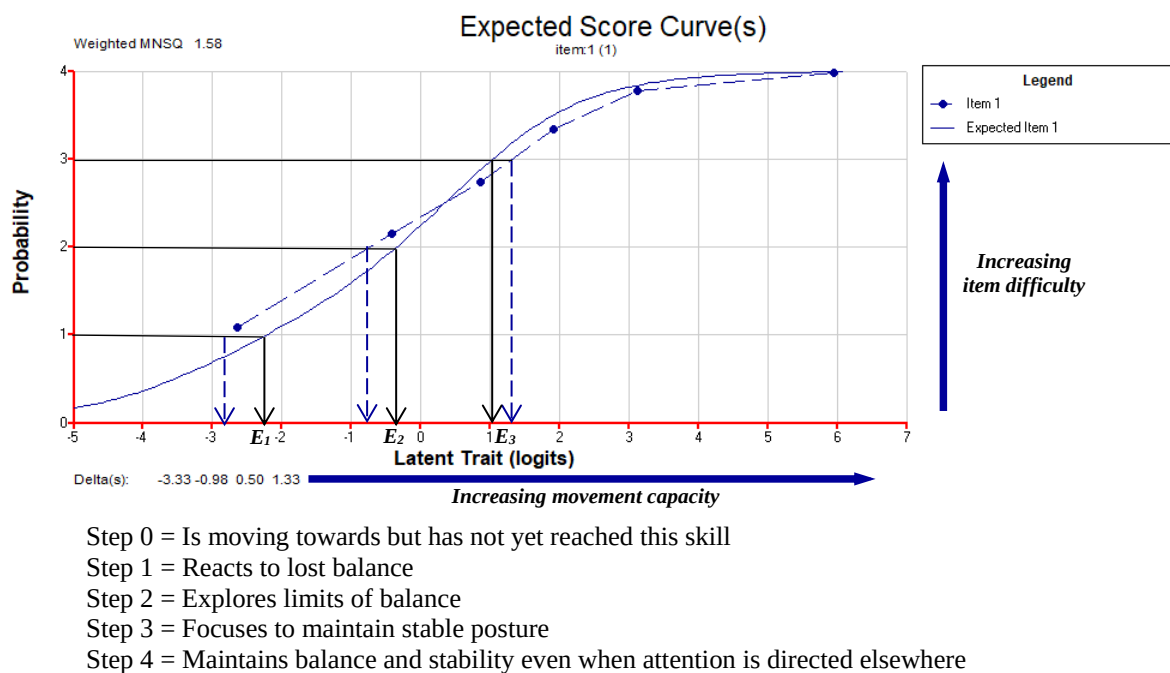


Figure 26. Movement Item 1: Maintains balance and upright posture

In Figure 26, the horizontal axis represents student ability/item difficulty by logits, the vertical axis shows the step scores for the item, the blue solid line provides the theoretical prediction, and the blue broken line identifies the observed, or empirical, result. The black lines divide the modelled line into score ranges, so that students performing at the ability level indicated by E1 had reached the threshold where they had a 50% likelihood of being accorded a score of 1 or more, those at ability level E2 were now 50% likely to receive a score of 2 or more, and so on. What the graph demonstrates is that the probability of moving from scores 0 to 1 and 1 to 2 was less difficult than the model predicted, while the probability of moving from score 3 to 4 was more difficult. In other words, it was easier than expected for low-ability students to achieve lower steps, and more difficult for higher ability students to achieve the top steps. This is also shown by Figure 27's item characteristic curves (ICCs) for each step –

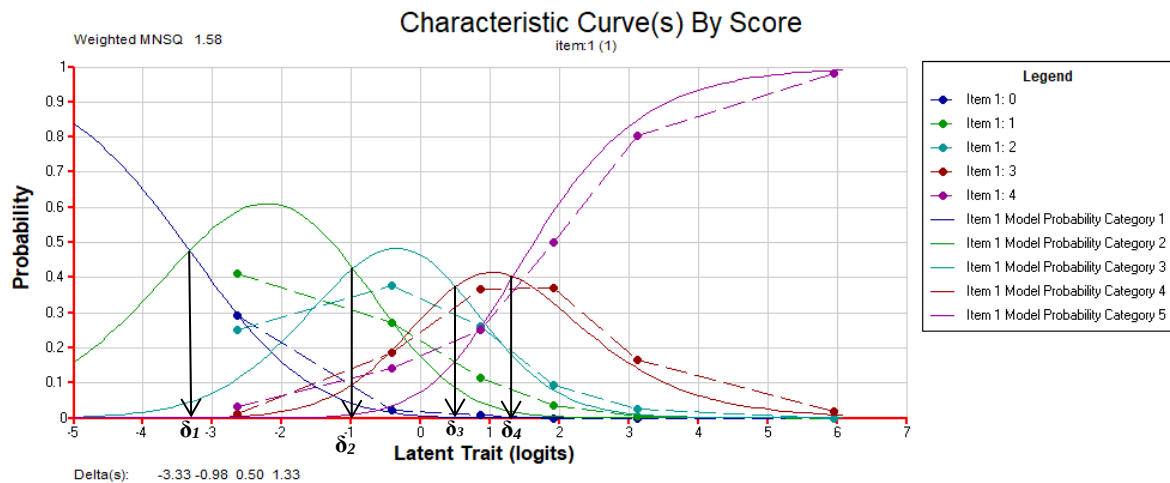
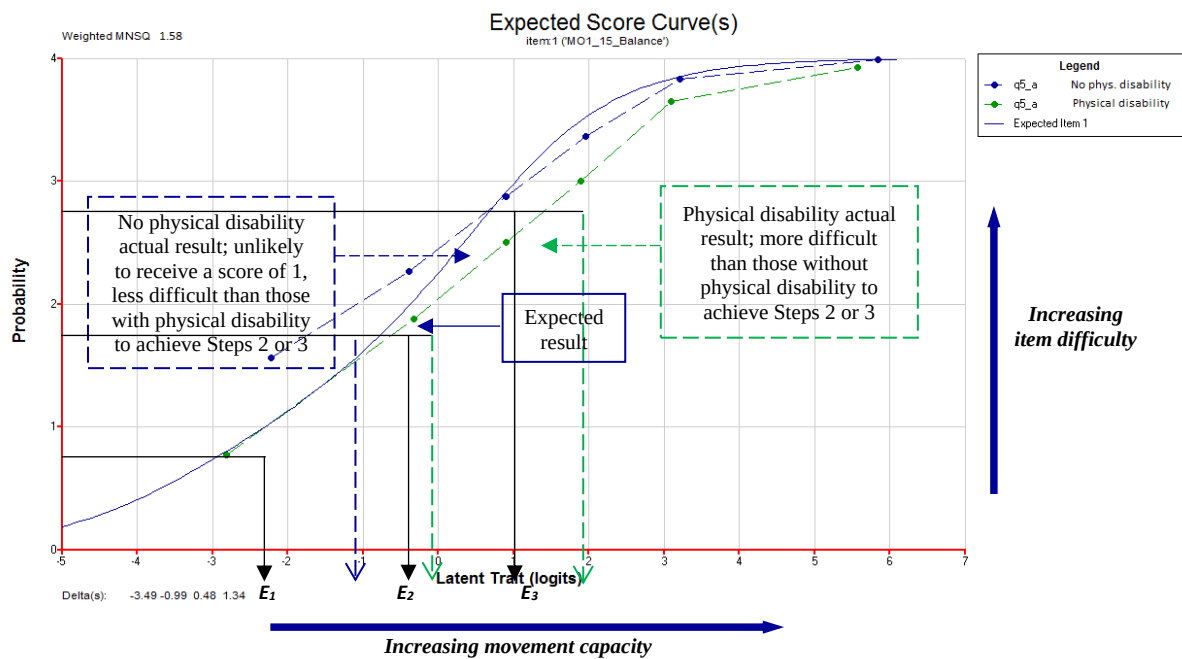


Figure 27. Movement Item 1: Characteristic curves by partial credit step

Figure 27 shows the expected (coloured solid lines) and actual (coloured broken lines) results for the five response categories of Item 1, beginning with Step 0 as the blue set. In between each delta (δ) parameter is the ability range (in logits) associated with a most probable single score category (Wu & Adams, 2007). Hence, below δ_1 , the likely score is 0, between δ_1 and δ_2 , the score is more likely to be 1 than 0, and so on. While the broken line curves, depicting the derived result, are sequentially ordered across the range as required, indicating increasing skill difficulty, each curve is flatter than the model predicted, particularly for the first two steps. In addition, the ability range where the third step becomes more probable than the second is narrow, and the probability of its selection remains below 0.5, so that the combined probability of scoring on either side (2 or 4) is always greater, even within Step 3's ability range.

As already noted, a possible cause for this item's poor performance is relative unfairness for students with physical disability. Figure 28 shows the separate performance of students with and without physical disability on this item.



Step 0 = Is moving towards but has not yet reached this step

Step 1 = Reacts to lost balance

Step 2 = Explores limits of balance

Step 3 = Focuses to maintain stable posture

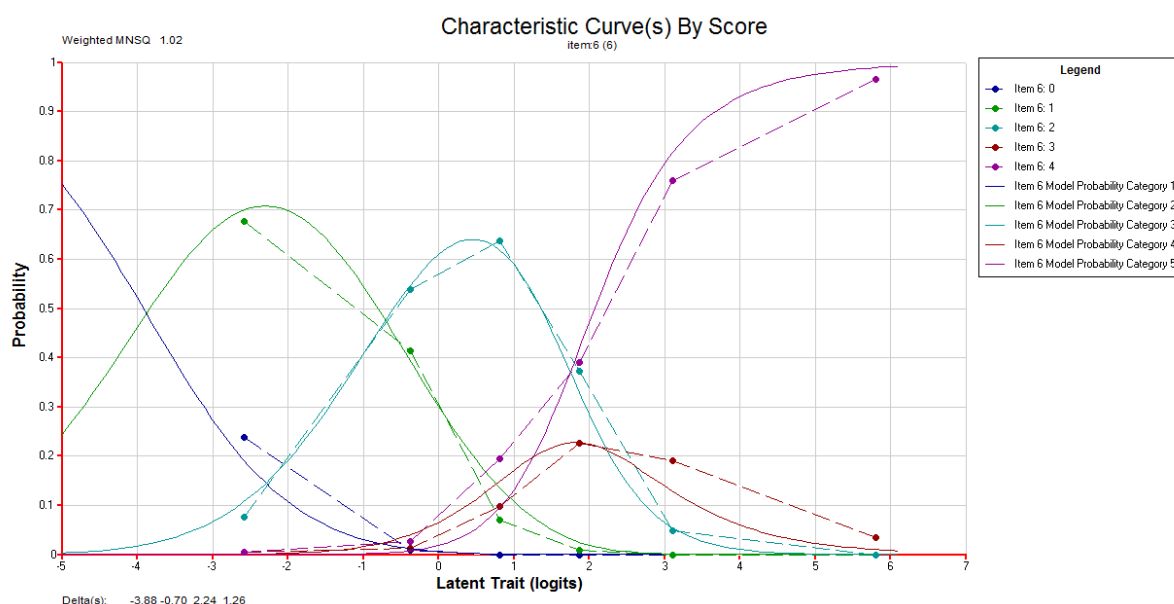
Step 4 = Maintains balance and stability even when attention is directed elsewhere

Figure 28. Movement Item 1: Differential item functioning for physical disability

This graph shows that for Item 1, few if any students without physical disability (blue broken line) were likely to receive a score of 1, and their 50% likelihood of achieving Step 2 or more (Exploring limits of balance), or 3 or more (Focusing to maintain balance) required less overall assessed ability than was the case for students with a physical disability (green broken line). In conclusion, for Item 1:

- Steps 1 and 4 had high fit statistics, and the score curve was flatter than expected, with randomness in scoring both lower and higher ability students,
- Step 3 remained a less than 50% probability of being selected than the steps on either side when put together, and
- There was significant deviation in the way students with and without physical disability at the same ability level were scored, with the latter more likely than their counterparts with physical disability to achieve scores of 2 or 3.

Item 6 – Moves from one position or place to another. A most likely single score category for each step as a function of ability was not demonstrated for item-step 6.3, related to practicing to improve, as it never became the most likely single selection. This is depicted by the item characteristic curves (ICC's) (Figure 29), where the infrequency of selection of the third (red) step has produced a flattened curve to the extent that the order of steps is affected, and the fourth step appears easier to achieve. This is also seen in the disordered delta parameters at the bottom of the graph, where the third step has a higher difficulty estimate (2.24 logits) than the fourth step (1.26 logits).



- 6.0 = Is moving towards, but has not yet achieved this level
- 6.1 = Shows awareness of being re-positioned or moved
- 6.2 = Focuses to move or reposition self in routine tasks
- 6.3 = Practices moving and repositioning to improve speed and efficiency
- 6.4 = Combines moving with other tasks (e.g., transports objects while moving)

Figure 29. Characteristic curves for movement item 6

Items 5 and 10 – aligning descriptions to derived placement on the scale. While the fit of items 5 and 10 was good and their delta parameters were ordered, items demonstrating acceptable psychometric properties may still benefit from review, especially where they have not performed as anticipated in the design phase of item development. Following calibration, these two items had been flagged because the derived placement suggested match problems

between the skill descriptions and the examples provided to teachers of how those skills might be demonstrated in the classroom. For item-step 5.3, the description concerned adapting to *new* circumstances (a more difficult skill), while its examples described moving in *typical* situations (moving over different ground surfaces; reaching objects at different speeds – easier skills). As the derived placement aligned the step to the difficulty of the description, it was the examples that appeared inconsistent. For item-step 10.3, on the other hand, the verb ‘exploits’ in the description implied innovative use of bodily capacities, while the examples concerned basic tasks (stabilising objects, managing personal belongings), where innovation would be unlikely to be seen. As the derived placement aligned this step to the difficulty of the examples, it was the verb that appeared inconsistent.

Having described the aspects of concern for these items, the next section summarises the decisions made by the expert group to improve them.

Item Renovation. Item 1. Analysis had revealed issues particularly with Steps 2, 3, and 4. While there was some randomness in allocation of students to Step 1, the expert panel considered this to be partly due to the relatively small number of students allocated to that level (5.4%). It was therefore retained, as expressing an important early skill supporting students with severe physical disability to be placed on the scale.

Step 2: It was firstly noted that balance exploration was a proactive balance skill, not a protective, or reactive one, and was therefore possibly tracking a different aspect of balance than intended. Secondly, in relation to DIF, the differences in score probability for students with and without physical disability indicated a possible bias against students with physical disability, therefore this step was recommended for removal.

Step 3: It was firstly noted that observing the skill of ‘focusing’ involves interpretation, opening this step to interpretive bias. In relation to DIF, the different score probability for able-bodied students again indicated a possible bias against students with physical disability,

arising from the reduced likelihood of them being seen in more challenging balance situations in the classroom. Therefore, this step was recommended for change to strengthen its visibility, and to align it more strongly to observable classroom opportunities for the target cohort, such as rule application.

Step 4: This step was retained, but as 55 students with physical disability achieved this level, a suggestion was to replace the removed Step 2 with one more difficult than the original step 4, to cater for these high performers. Drawing on Gentile's taxonomy of increasingly complex skills, the final step included the requirement of balance in conditions of instability (Gentile, 2000; Gordon & Magill, 2012). Consequently, the item became –

Step 1 = Reacts to lost balance

Step 2 = Relies on strategies or cues to maintain stable posture

Step 3 = Maintains balance and stability even when attention is directed elsewhere

Step 4 = Masters orientation to gravity during unstable activities.

Item 6. The expert panel considered the third step had been under-selected partly because 'practising', like 'exploration' in Item 1, is a proactive skill focused on its own improvement, rather than being an expression of functional or task-related behaviour. In addition, it was proposed that 'practising movement to improve speed and efficiency' is not how teachers typically perceive movement behaviour in the classroom. Therefore, this step was recommended for removal. It was also proposed that the final step contained 'stringency inconsistency' between its description (relatively difficult) and examples (relatively easy), and that the latter needed re-writing to more consistently reflect a high-quality performance. Consequently, the item became –

Step 1 = Shows awareness of being re-positioned or moved

Step 2 = Focuses to move or reposition self in routine tasks

Step 3 = Masters fluency and control when moving or repositioning quickly (*e.g., changes direction smoothly in response to demands of a game; negotiates crowded hallways without difficulty; fluently achieves multi-step tasks*).

Items 5 and 10. The decision taken in relation to item-step 5.3 was to scale up the examples to better reflect the difficulty of the skill description. These therefore became, *‘Changes strategy to reach accurately at different speeds; alters gait quickly in response to suddenly changed conditions; combines sequences/ strategies to achieve more of a task.’* The goal with this change was to better support consistent assessor interpretation. For item-step, 10.3, the decision was to replace the more demanding verb ‘exploits’, with ‘uses’, to align it to the routine and repetitive nature of the tasks in the examples.

New items. Lastly, three new items were proposed for inclusion in the main study, to cater for higher ability students and improve domain coverage, particularly of the extensive fine-motor and handwriting requirements of classroom learning, and in relation to motivation. These items described the skills of obtaining objects, handwriting, and seeking movement challenges. Table 29 shows their hypothesized proficiency steps and Table 30, the item renumbering to include these additions. In total, 19 items and 63 proficiency indicators were tabled for the study’s main data collection with students with motor performance needs.

Table 29 *Proposed New Items for the Main Study*

New item	Proficiency steps
9. Obtains objects	1 Uses a familiar strategy or method for obtaining objects 2 Varies strategies for obtaining objects 3. Adapts/adjusts strategies for obtaining objects to meet changing requirements
13. Uses writing and drawing implements	1 Scribbles, or makes marks on paper 2 Copies or traces over patterns or shapes 3 Achieves legible handwriting when writing slowly 4 Maintains legible and fluent handwriting in demanding or novel writing tasks
16. Seeks movement experiences and challenges	1 Shows awareness of activities placed nearby 2 Attempts greater physical involvement in classroom tasks 3 Creates opportunities to move from classroom activities

Table 30. *Re-numbering of the Main Study Instrument*

Numbering		Items	
Trial	Main Study	Trial and Main Study	Main Study additional items
	1	Maintains balance and upright posture	
	2	Regulates physical tension	
	3	Sensory response	
	4	Positions for activity	
	5	Remembers a movement sequence	
	6	Moves from position/place to another	
	7	Avoids obstacles	
	8	Uses sporting or activity equipment	
	9		<i>Obtains objects</i>
9	10	Transports objects from place to place	
10	11	Manages personal school equipment	
11	12	Manipulates and uses tools and materials	
	13		<i>Uses writing implements</i>
12	14	Shares space interactively	
13	15	Moves for self-expression/ communication	
	16		<i>Seeks movement challenges</i>
14	17	Perseveres in movement tasks or activities	
15	18	Works within physical limits	
16	19	Completes tasks involving strenuous effort	

Chapter Summary

This chapter has set out the initial calibration of trial items developed for the learning progression, including demographic characteristics of participating schools, teachers and students, and processes followed to improve item fit and content coverage ahead of the main study of students with motor performance needs. The items were a proposed indicative set invariant for the target group, attempting to describe learnable motor problem-solving in the context of real tasks, not the learning of normative motor solutions.

In response to the first research question concerning a typical developmental learning progression, calibration of results from the trial established a unidimensional item pool with very good internal consistency as indicated by the high Cronbach alpha statistic, good statistical fit to the Rasch model as indicated by acceptable infit mean square values for all but Item 1, high indices of person and item separation reliability indicating the scale was able to separate students by ability on the construct, and a good match of items to student abilities at beginning levels of skill.

In response to concern for scale invariance, results indicated a largely invariant set of items by the acceptable infit statistic range of 0.75 to 1.33. However, construct-irrelevant sources of variance, or DIF, operated in Item 1. Changes to this item included removing the step of proactive exploration of balance limits and describing the step of focusing in more classroom-observable terms. Other changes made ahead of the main study were removal of the notion of practising from Item 6, altering the wording of Items 5 and 10 to improve consistency between item description and examples, and expanding domain coverage to cater for higher ability students, and to include the important classroom skill of handwriting. Chapter Seven next reports on the main study and responds to the second research question, concerning a multidimensional scale interpretation more consistent with the presence of sub-categorisations in the literature, and more supportive of nuanced understandings of ability.

Chapter Seven: Study 1 (Main Study) Results

This chapter reports on the results of analysis of the main study of students with motor performance needs, and responds to the second research question:

To what extent is the developmental learning progression for goal-directed movement a multidimensional construct?

It proceeds firstly to report statistics of scale reliability, item parameter estimates, and item difficulty and person ability estimates, followed by an individual item review and, finally, consideration of possible sub-dimensions within the scale.

Difficulty Hierarchy and Dimensionality

Statistical Analysis of Results

A unidimensional IRT analysis for items scored in a partial credit fashion (Masters, 1982) was conducted on the results from the 650 students assessed for the main study, using ACER ConQuest IRT software (Adams, Wu, & Wilson, 2015). Appendix H provides the statistical output files. As with the trial results, traditional statistical results returned a high reliability coefficient (Cronbach's alpha) of 0.97, indicating a high degree of internal consistency across the items when viewed together as a set. Item separation reliability was 0.98, which suggested that individually, the items spread well along the continuum, enabling it to be defined as a meaningful learning progression. The person separation reliability was also high, at 0.97, indicating students were well separated along the scale. Together, these figures gave support for the construct validity of the scale. Table 31 sets out the calibration estimates for the 19 items.

Table 31 *Calibration Estimates for the Main Study Items*

Item (number and description)		Difficulty (δ_i)	Error	Item- Rest	Infit WMNSQ
1	Maintaining balance, upright posture	-0.07	0.06	0.73	1.43^a
2	Regulating physical tension	0.41	0.08	0.60	1.36
3	Coordinating sensory response	-0.21	0.07	0.78	1.08
4	Positioning self to engage in activity	-0.34	0.06	0.83	0.94
5	Remembering a movement sequence	-0.16	0.07	0.82	0.88
6	Moving from position/ place	-0.51	0.08	0.81	0.79
7	Avoiding obstacles	-0.28	0.07	0.77	1.07
8	Using sporting or activity equipment	-0.37	0.07	0.84	0.75
9	<i>Obtaining objects^b</i>	<i>-0.49</i>	<i>0.07</i>	<i>0.76</i>	<i>1.05</i>
10/9 ^c	Transporting objects place to place	0.04	0.07	0.85	0.80
11/10	Managing personal school equipment	-0.85	0.07	0.83	0.82
12/11	Manipulating tools and materials	0.11	0.07	0.82	0.79
13	<i>Using writing/ drawing implements</i>	<i>1.23</i>	<i>0.08</i>	<i>0.76</i>	<i>1.23</i>
14/12	Sharing space interactively with others	-0.46	0.08	0.75	0.96
15/13	Self-expression and communication	-0.21	0.08	0.65	1.33
16	<i>Seeking out movement challenges</i>	<i>-0.69</i>	<i>0.08</i>	<i>0.79</i>	<i>0.90</i>
17/14	Persevering in movement tasks	0.53	0.07	0.85	0.79
18/15	Working within physical limits	1.10	0.08	0.76	1.00
19/16	Completing strenuous movement tasks	1.21	0.07	0.82	1.02

Note: Figures shown in bold throughout the table refer to items outside the recommended 30% range for acceptable fit to the Rasch model (0.75-1.33). ^b Item descriptions in italics refer to the new main study items. ^c Where the first column contains two numbers, the first pertains to the final numbering of items for the main study, and the second, the original numbering of items used in the trial.

Difficulty estimates for the items and standard errors were acceptable, and the item-rest correlations indicated overall alignment of item to test performance, with slightly lower correlation for Items 2 and 15 (0.60 and 0.65 respectively).

The infit statistic in the final column indicated a good fit to the Rasch model (1980) for 17 of the 19 items. Just over half (10) of the items over-fit the model, which is preferable in relation to discrimination and reliability, as “‘good fit’ items by mean square values close to 1

are items with ‘mediocre’ discrimination” (Wu et al., 2016, p.152). Item 1 (Maintaining balance and posture) again evidenced underfit by an infit value of 1.43, and Item 2 (Regulating physical tension), at 1.36, was now just outside the acceptable 30% range (Adams & Khoo, 1996; Wright & Masters, 1982), though still within the more generous allowance of 0.5 to 1.5, indicating ongoing usefulness to measurement construction (Wright et al, 1994). Item 15 (Using movement for self-expression and communication, original Item 13) now had a fit statistic of 1.33. Discussion of these items individually follows the next section on item difficulty and person ability estimates.

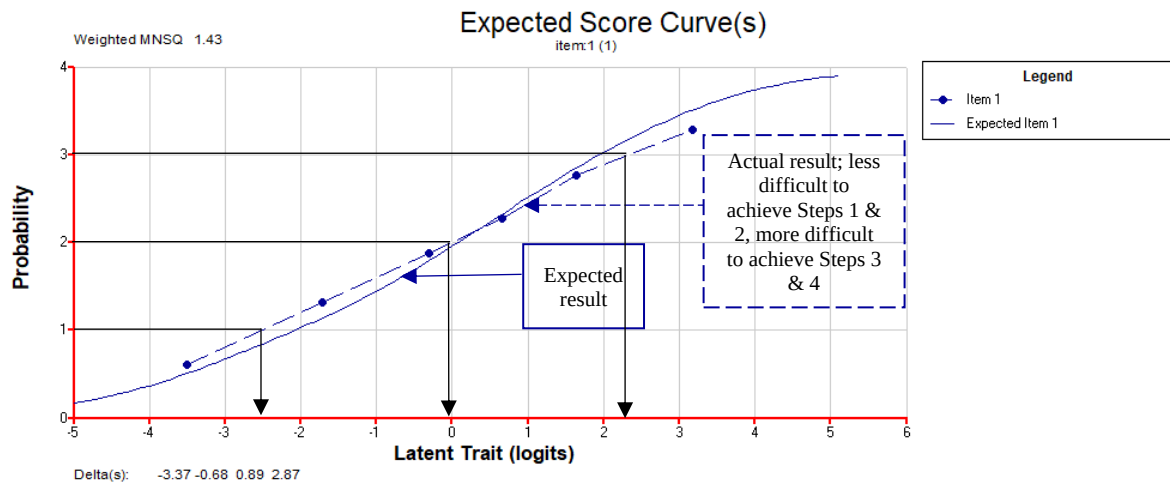
Item Difficulty and Person Ability Estimates. Figure 30 depicts these results on an item-threshold map, which depicts student distribution as ‘X’s on the left-hand side, aligned to logits reflecting increasing difficulty in the underlying construct, and on the right-hand side, parsed, and similarly aligned, the item steps, so that items and test-takers function together to define the latent trait. Each X represents one student.



Item-step 3.1 was the easiest – “*Attends to the sensory aspects of objects or environment*”, with students requiring ability equivalent to - 4.76 logits to have a 50:50 chance of achieving this score. At logit ‘0’, mean difficulty for the scale (Bond & Fox, 2015), students had an equal chance of achieving 10.2 – “*Concentrates to achieve transport of self and object(s)*”, and 15.2 – “*Uses a consistent repertoire of gestures/ expressions to establish meaning*”. New item-step 13.4 became the hardest skill, at 4.62 logits – “*Maintains legible and fluent handwriting in demanding/ novel writing tasks.*”

The map demonstrates that the item proficiency steps were well spread along the variable and targeted the range of abilities well, and that assessors could use them to assess students. Twelve students only (1.8%) had a less than even likelihood of achieving 3.1 or more, and 6 students (0.9%) a greater than even likelihood of achieving 13.4, indicating no significant floor and ceiling effects for this cohort. A review of individual item performance now follows, particularly of underfitting items from the trial, and the performance of renovated items from the main study.

Individual Item Review. Item 1: Maintains balance and upright posture. Firstly, the inclusion of a more difficult fourth step successfully increased the difficulty of this item, as evidenced by a delta difficulty estimate increase from 1.52 to 2.87 logits. However, the item continued to underfit the Rasch model, though not to the same extent, with Figure 31 indicating an infit score of 1.43.



Step 1 = Reacts to lost balance

Step 2 = Relies on strategies or cues to maintain stable posture

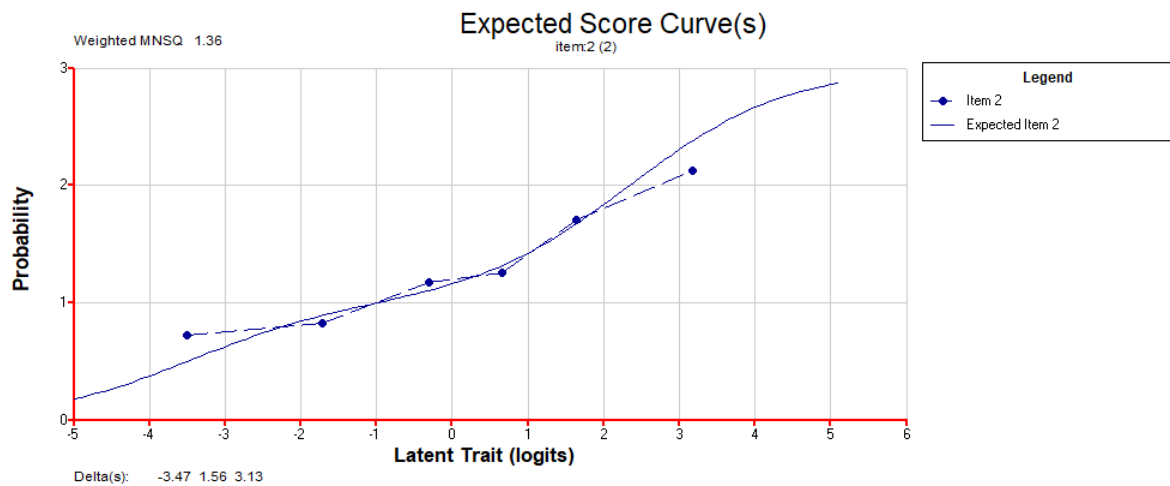
Step 3 = Maintains balance and stability even when attention is directed elsewhere

Step 4 = Masters orientation to gravity during unstable activities

Figure 31. Performance of renovated item 1 in the main study

As was the case in the trial, lower ability students were more likely than predicted to achieve lower scores, and higher performing students less likely to receive the higher scores. As more variation in performance is typical at the extremes of a score distribution, one simple explanation for this misfit is the few students at these extremes. Compared to the approximately 25% of students who were allocated to steps 1, 2, and 3, steps 0 and 4 were awarded to only 11 and 12% of students respectively. An additional consideration is the relevance of balance to all movement (Bernstein, 1996; Shumway-Cook & Woollacott, 2012). As Chapter Three's literature review noted, while some descriptions of the motor domain separate out the dimension of balance and posture (Newell, 1991), others combine it with mobility (Coster et al, 1998; Gentile, 1987), so intrinsically does it tie to other skills. This suggested a further possible reason for the item's underfit being its complex associations, which might be better supported by a multidimensional analysis of results (Wu et al., 2016).

Item 2: Regulates physical tension. The underfit of this item increased slightly from the trial, from 1.25 to 1.36, now falling just outside the acceptable 30% range of 1.33 (Adams & Khoo, 1996; Wright et al, 1994). Figure 32 demonstrates this underfit related mainly to first and last steps, with students of low-ability being unexpectedly awarded the first step – reacting to stimulation or emotion, and students with high-ability students being less likely to achieve the top step of regulating dynamic bodily tension.



- Step 1 = Reacts to stimulation or emotion (e.g., changes level of engagement or breathing rate)
- Step 2 = Uses a strategy to manage physical tension during activity (e.g., requests a break; calms by linking breathing to a slow, repetitive movement)
- Step 3 = Regulates physical tension and response during activities with changing energy demands (e.g., calms for quiet activity following activity with raised energy)

Figure 32. Performance of item 2 in the main study

Statistically, the proportion of students achieving each of Steps 1, 2, and 3 was 56.5%, 22%, and 9.5%, indicating the reduced likelihood of being awarded purposeful tension self-regulation, as Step 1 is a reactive capability only. This can be seen in the item characteristic curves of Figure 33.

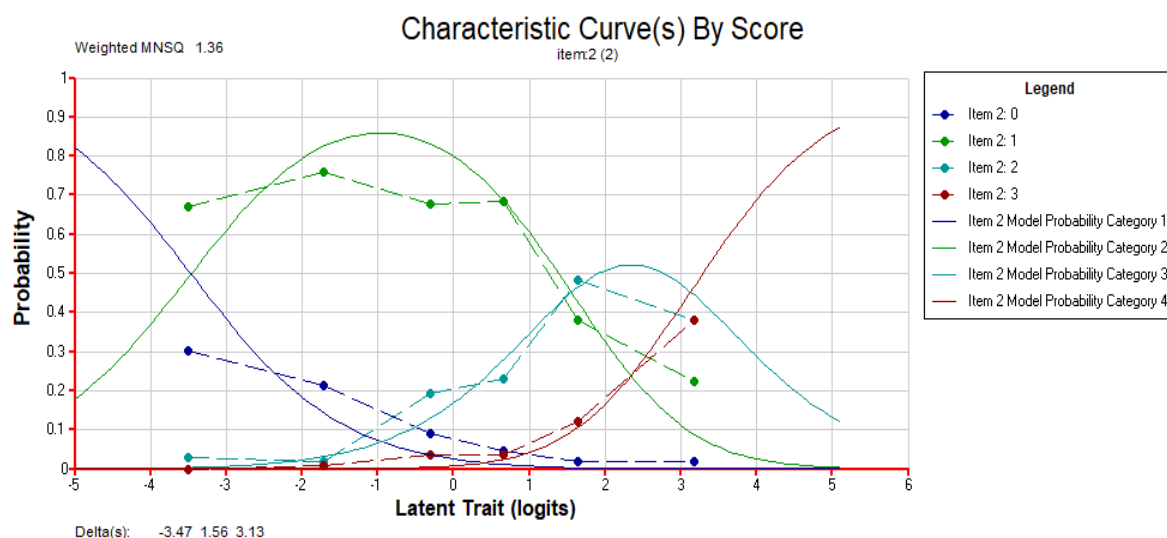
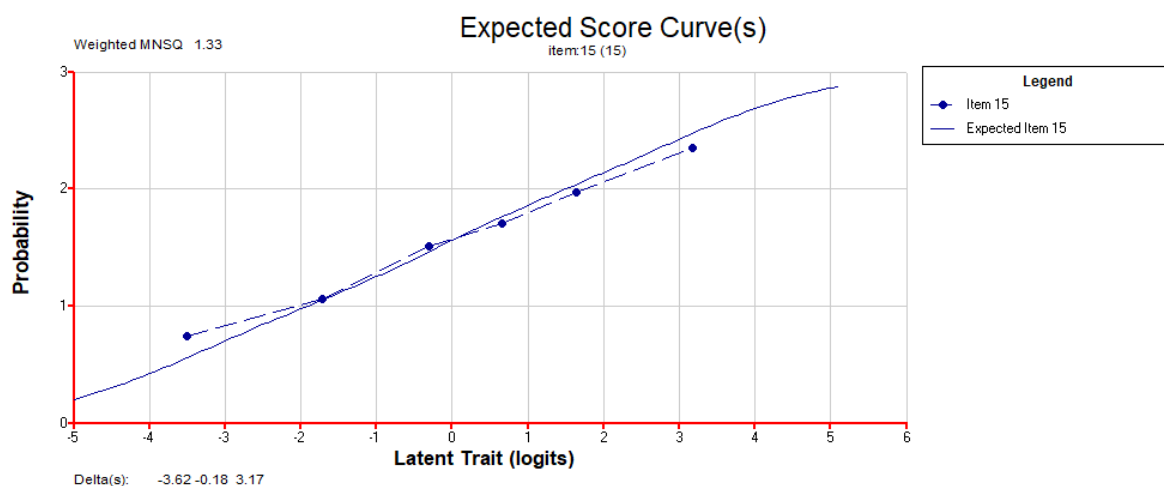


Figure 33. Characteristic curves for movement item 2

Figure 33 demonstrates the increased likelihood of being scored at Step 1 over Steps 2 and 3, with the flattened green broken line (Step 1) comparing to the steeper aqua broken line that does not quite rise to 0.5 (50:50) probability (Step 2), and the red broken line that also falls well short of 50% likelihood (Step 3).

The ability to manage tension and control one's behaviour is an important classroom skill that also requires a behavioural willingness to do so when instructed, hence it is likely some students capable of this skill were scored down for unwillingness to settle, rather than difficulty doing so. A further consideration is the possibility of relationship of this skill to social interactiveness and personal communication (Harbonnier-Topin & Ferri, 2011; Jones et al., 1999; Renk et al., 2011), and hence the chance of a better fit via a multidimensional analysis that groups it with communication/ interaction items specifically.

Item 15 (renumbered Item 13): Moves for self-expression and communication. The underfit of this item was 1.33, so within acceptable bounds. Figure 34 identifies the increased likelihood of students at beginning levels of ability being awarded the first step – communication interpretable to familiar others, but reduced likelihood of achieving the last step – extending and expanding what can be communicated by the body.



Step 1 = Uses gestures/ facial expressions interpretable to familiar others

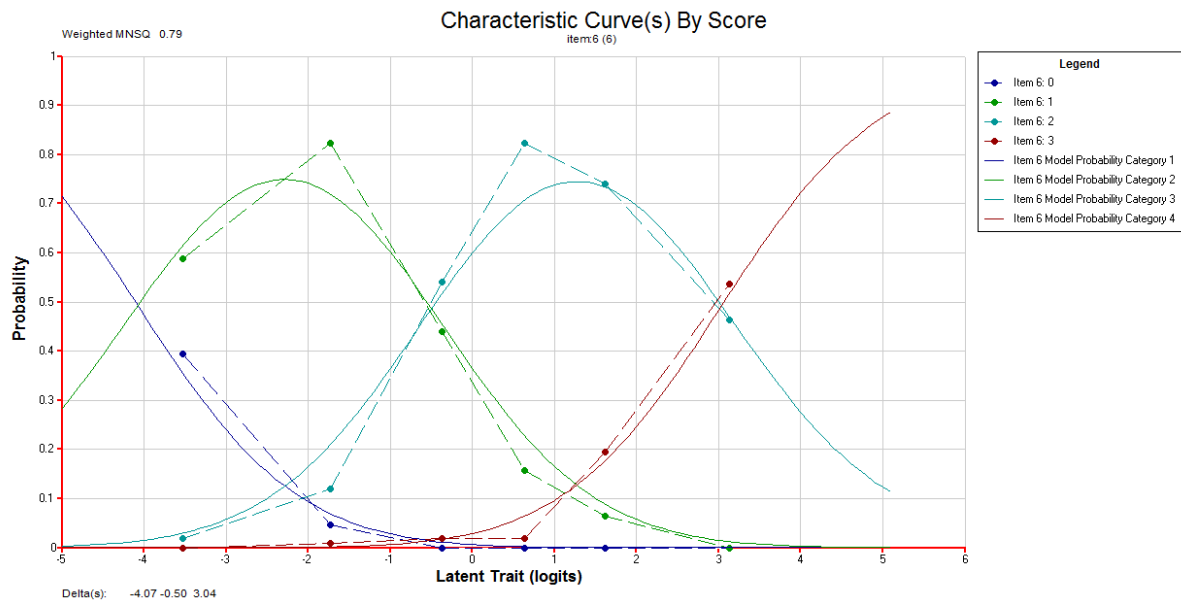
Step 2 = Uses a consistent repertoire of gestures/ facial expressions to establish meaning

Step 3 = Expands and extends what can be communicated by the body

Figure 34. Performance of item 13 (item 15 for the main study)

At its lowest step, this item enabled teachers to identify elements of capacity and movement potential in students they may otherwise have assumed to lack intentional movement capability. As the first step drew on the receptive and comprehension skills of the communication partner, it was also unsurprising that it was an easier skill to award. Overall, however, using the body and hands as an “interaction medium” is an applied and complex skill, that draws upon language and cognitive processing skills, as well as different combinations of the skills of the domain, to achieve performance requirements (Chien, Brown & McDonald, 2009, p.875). Where this complexity exists, a multidimensional analysis of results should be considered (Wu et al., 2016).

Item 6: Moves from one position or place to another. In the trial, the third step of this item was rarely selected, resulting in delta disordering of the third and fourth steps. Figure 35 demonstrates that the deletion of the third step has removed the disordering, and that the item now overfits the model acceptably. In addition, the difficulty of this item has improved, as evidenced by the delta for the final step moving from 2.15 to 3.04. This was the goal of the provision of more difficult-to-achieve examples.



- Step 1 = Shows awareness of being re-positioned or moved
 Step 2 = Focuses to move or reposition self in routine tasks
 Step 3 = Masters fluency and control when moving or repositioning quickly (e.g., changes direction smoothly in response to demands of a game; negotiates crowded hallways without difficulty; fluently achieves multi-step tasks)

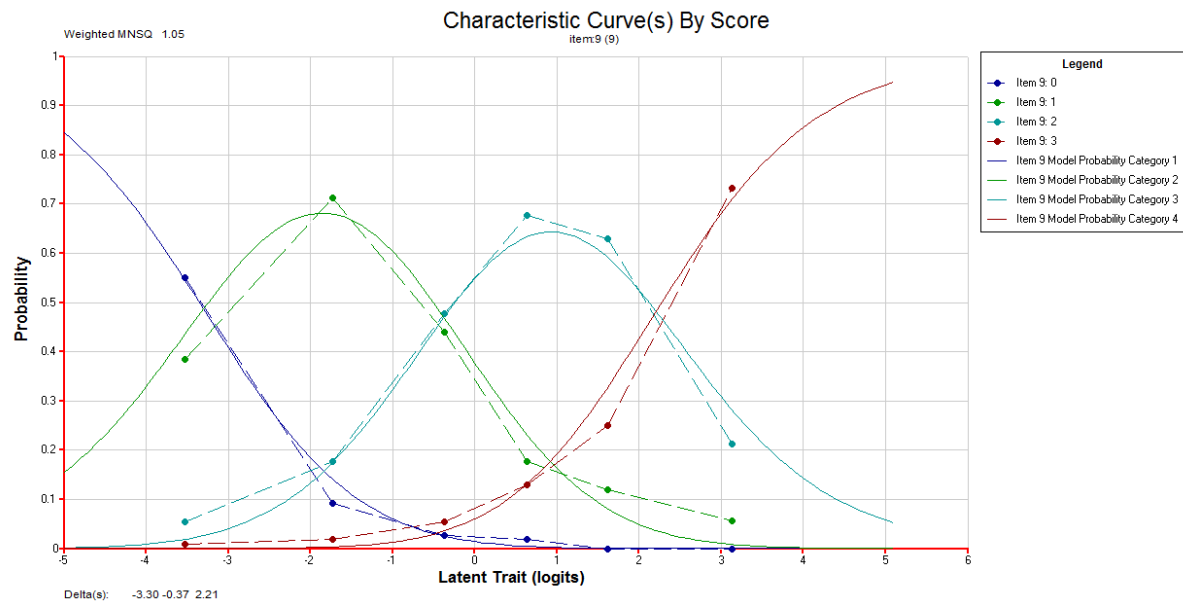
Figure 35. Performance of renovated item 6 in the main study

Item 5: Remembers a movement sequence. The goal of provision of harder examples for the third step of this item was to ensure greater consistency between the examples and the derived position of the step from the trial. This was achieved in that its position equated the item by difficulty to others describing movement capability in situations of novelty or changing demand, such as 3.4 – adapting responsively to changing sensory input, 8.3 – adjusting movement response to engage with equipment and activity, and 7.3 – modifying movement to avoid obstacles.

Item 10: Managing personal school equipment. Renovation of this item following the trial study involved lessening the demand of the verb of the third step – from ‘exploits possibilities of body and environment’ to ‘uses a range of movement strategies’, to bring it more in line with the examples given for that step, and its derived position, and to better reflect the skill level of surrounding item steps that focused on learned strategies (e.g., 18.2 –

adhering to rules to regulate involvement, and 2.2 – using strategies to manage physical tension during activity).

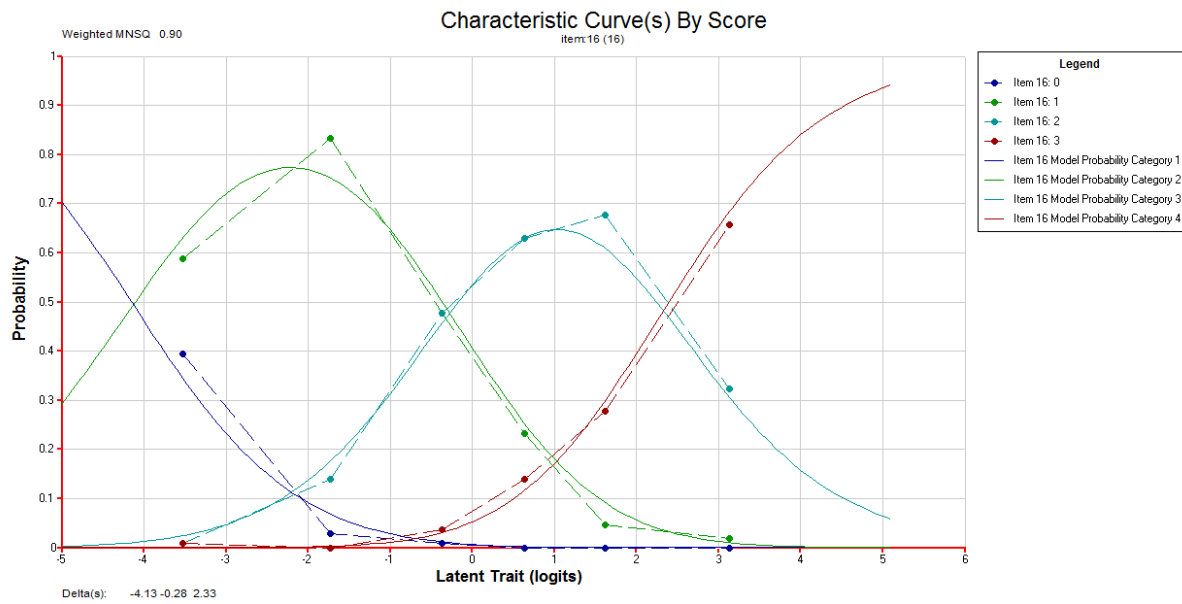
New items 9, 16, and 13. Item 9 (“*Obtaining objects*”) evidenced good fit to the model (mean square 1.05; Figure 36).



- Step 1 = Uses a familiar strategy or method for obtaining objects (e.g., the same raking or swiping strategy for bringing all objects to self)
- Step 2 = Varies strategies for obtaining objects (e.g., one-handed or two-handed methods)
- Step 3 = Adapts strategies for obtaining objects to suit requirements or prevent problems (e.g., alters grip to secure object; retrieves object from table while moving past it)

Figure 36. Characteristic curves for new item 9: Obtaining objects

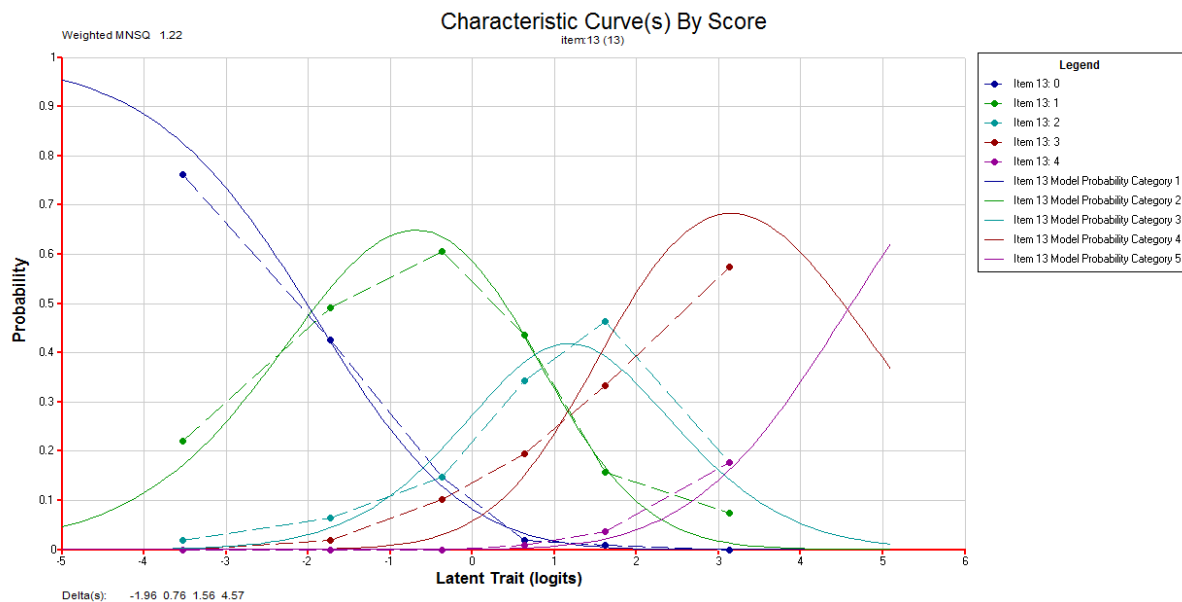
Similarly, Item 16 evidenced good fit (“*Seeking out movement experiences and challenges*”), with a fit of 0.90 – see Figure 37.



- Step 1 = Shows awareness of activities placed nearby (e.g., lifts head; vocalises)
- Step 2 = Attempts greater physical involvement in classroom tasks (e.g., puts up hand to block or reduce helper involvement)
- Step 3 = Creates opportunities to move from classroom activities (e.g., experiments with different ways to mobilise around the classroom)

Figure 37. Characteristic curves for new item 16: Seeking movement experiences

Figure 38 shows the new handwriting item 13, with an infit statistic of 1.22.



- Step 1 = Scribbles, or makes marks on the paper
- Step 2 = Copies or traces over patterns and shapes
- Step 3 = Achieves legible handwriting slowly or when completing familiar writing tasks
- Step 4 = Maintains legible and fluent handwriting in demanding or novel writing tasks (e.g., when writing at speed or for long periods; when writing with different sizes/ types of writing implements)

Figure 38. Characteristic curves for new item 13: Using writing and drawing tools

The item showed good fit to the model and there were no disordered step parameters, though Step 2's selection (aqua line) was less likely; in other words, though the skill of "*Copies or traces over patterns and shapes*" was the most likely single score range for students between logit ability 0.75 and 1.56, this never reached 50% probability, while the combined probability of the two steps on either side retained greater than 50% likelihood of being chosen (Wu & Adams, 2007). The fourth step (pink line) – "*Maintains legible and fluent handwriting in demanding or novel writing tasks*" was the most difficult of the entire scale, being selected for only 3.5% of the highest performing students.

Handwriting is an important classroom skill, and difficult for many students with mild motor difficulties to achieve (Chapparo & Lowe, 2012; Rosenblum, Margieh, & Engel-Yeger, 2013). As noted in Chapter Three's literature review, improving the "secretarial" aspects of handwriting falls predominantly to occupational therapists (Graham, 2009, p.20), therefore, further consideration of this item was tabled for the second study, involving paediatric occupational therapy experts considering the major stages of learning goal-directed movement, and the implications for reporting results.

Item Difficulty Hierarchy. Masters' (1982) partial credit analysis enabled the skills of the items to be laid out by relative difficulty, which, for a unidimensional construct, produced a single pathway with skills of like difficulty clustering together. The goal of this calibration was to understand these clusters and describe their common themes, a process of setting standards that enabled assessment results to be connected to differentiated instruction. As stated in Chapter Four's literature review, Glaser's (1981) concept of criterion-referenced interpretation applied, where criteria were boundary markers between *levels* of increasing proficiency, and criterion-referencing was a process of gathering evidence of attainment and referring results to these threshold boundaries, enabling the current level, and next focal stage to be identified (Griffin, 1997). Calibration of the motor skills developed in this study

demonstrated clusters of skills by like difficulty, with Table 32 presenting a possible matching to levels on a unidimensional scale (ascending order). Cut-points have been made by attending to likely substantive threshold criteria, rather than using the gaps between logit scores as the only determinant of change from one stage to the next.

Table 32 *Alignment of Unidimensional Construct to a Levels Framework*

Proposed levels	Step	Logit	Description
Level 6 – Moves creatively, maximising what is possible	13.4	4.57	Maintains legible and fluent handwriting in demanding/ novel writing tasks
	17.4	3.84	Adapts movement strategies to more challenging settings
	19.4	3.82	Completes strenuous movement activities comfortably
	18.3	3.34	With planning, achieves maximum involvement possible within limits
	15.3	3.17	Extends and adapts repertoire of gestures to suit different needs or audiences
	3.4	3.17	Manages performance involving more than one demand
	2.3	3.13	Regulates physical tension and response during changing energy demands
Level 5 – Achieves efficient, fluent movement in novel tasks	6.3	3.04	Masters fluency and control when moving quickly
	4.4	3.02	Anticipates/adjusts position throughout activity to support functioning
	1.4	2.87	Masters orientation to gravity during unstable activities
	12.3	2.86	Manipulates/uses tools with appropriate control while attention elsewhere
	8.3	2.69	Adjusts movement response to meet requirements of equipment or activity
	14.3	2.4	Cooperates with others to share the space
	5.3	2.4	Adapts a movement sequence to suit new circumstances
	16.3	2.33	Creates opportunities to move from classroom activities
Level 4 – Moves successfully while completing other aspects of routine tasks	10.3	2.27	Transports objects while engaged on other task aspects
	7.3	2.26	Modifies movement to avoid obstacles of past difficulty or suddenly arisen
	9.3	2.21	Adapts strategies for obtaining objects to suit requirements/avoid problems
	19.3	2.13	Manages a strenuous activity slowly, or with rest periods
	17.3	2.04	Initiates an attempt at new/ more difficult aspects of tasks
	18.2	1.73	Adheres to rules regarding level of involvement and activity choice
	11.3	1.63	Uses a range of movement strategies to manage personal school equipment
	13.3	1.56	Achieves legible handwriting when writing slowly in familiar writing tasks
	2.2	1.56	Uses a strategy to manage physical tension during activity
	3.3	1.18	Practices moving under different sensory conditions
	1.3	0.89	Maintains balance with attention directed elsewhere

Proposed levels	Step	Logit	Description
Level 3 – Completes routine movement tasks by following instructions and when singly focused	13.2	0.76	Copies or traces over patterns and shapes
	12.2	0.49	Focuses/slows to use tools with appropriate control
	14.2	0.44	Manages own needs in shared space
	4.3	0.25	Positions self to commence activity
	19.2	0.01	Engages in occasional strenuous movement in activity
	15.2	-0.18	Uses a consistent repertoire of gestures/ expressions to establish meaning
	16.2	-0.28	Attempts greater physical involvement in classroom tasks
	10.2	-0.28	Concentrates to achieve transport of self and object(s)
	9.2	-0.37	Varies strategies for obtaining objects
	3.2	-0.42	Focuses on the sensation of moving to achieve routines
	6.2	-0.5	Focuses, or attends consciously, to reposition self during routine tasks
	8.2	-0.65	Uses equipment in familiar activities
	1.2	-0.68	Relies on strategies or cues to maintain stable posture
	11.2	-0.75	Achieves a component of equipment handling
	7.2	-0.77	Attempts to avoid obstacles in familiar settings
	5.2	-0.8	Repeats a simple sequence in imitation or from memory
	17.2	-0.99	Completes tasks within capacity with prompting or support
Level 2 – Achieves aspects of movement tasks in dependence on others	4.2	-1.12	Assists in being positioned for activity engagement
	19.1	-1.23	Maintains energy output for simple routine tasks
	18.1	-1.82	Relies on direct instruction to regulate involvement
	10.1	-1.85	Cooperates in tasks involving transport of routine items
	13.1	-1.96	Scribbles, or makes marks on the paper
	5.1	-2.14	Cooperates with the next step of a routine movement
	7.1	-2.31	Reacts when moved around obstacles or narrow spaces
	17.1	-2.77	Participates in activities easily achieved, or providing immediate reward
Level 1 – Observes, experiences, and attends to movement.	12.1	-3.03	Responds to sensory properties of tools and materials
	8.1	-3.13	Attends to properties or functions of equipment
	9.1	-3.3	Uses a familiar strategy or method for obtaining objects
	1.1	-3.37	Reacts to lost balance
	11.1	-3.42	Attends to equipment when placed in hand or nearby
	2.1	-3.47	Reacts to stimulation or emotion
	4.1	-3.51	Responds to activity when positioned in front of it
	15.1	-3.62	Uses gestures/ expressions interpretable to familiar others
	6.1	-4.1	Shows awareness of being re-positioned or moved
	16.1	-4.13	Shows awareness of activities placed nearby
	14.1	-4.2	Reacts or attends when others come close
	3.1	-4.75	Attends to the sensory aspects of objects or environment

Consideration of Dimensionality

Reviewing this learning progression, the interpretability of the levels proposal has been impacted by the placement of item proficiency steps onto a single scale. This has resulted in different skills being clustered together and subsumed under each level's general description, resulting in difficulties identifying specific skill development needs. Research has noted that unidimensional descriptions can result in domain specifics becoming “washed away in the composite” (Burton & Rodgerson, 2001, p.353), which, in addition to fit concerns noted in this chapter for the composite skills of balance (Item 1), and communication (Item 15), provides a case for conducting a multidimensional analysis of the data.

Chapter Three's literature review had identified various skill divisions in the motor behaviour literature, resulting in the hypothesized framework for testing depicted in Figure 10 of Chapter Four. Chapter Five then described an IRT means for establishing sub-aspects, or skill clusters, in an item pool, namely, between-item multidimensional IRT (MIRT) analysis, which hypothesizes sub-dimensions and loads respective items onto these to see if fit improves (Adams, Wilson & Wang, 1997; Wu et al., 2016). Two possible loadings of the 19 skills developed for the data-collection instrument were proposed – the first, into three-dimensional – 1) maintenance and change of body position, 2) maintenance and change of object position, and 3) management and maintenance of physical engagement; and the second, into five-dimensions – 1) balance and postural control, 2) transportation of self and objects, 3) manipulation, 4) communicative and interactive skills, and 5) performance sustainment. Chapter Five (Table 17) had also proposed alternative item-allocations for these proposals, repeated here (Table 33), ahead of a statistical evaluation of their relative fit.

Table 33 *Multidimensional Categorisations of the Item Pool with Proposed Loadings*

3-dimensional categorisation		5-dimensional categorisation	
Dimension	Items	Dimension	Items
<u>Dimension 1:</u> Maintenance and change of body position	1. Maintaining balance and upright posture; 4. Positioning self to engage in activity; 5. Remembering a movement sequence/ strategy; 6. Moving from one position/place to another 7. Avoiding obstacles/ preventing problems 15. Self-expression and communication 19. Completing strenuous movement tasks	<u>Dimension 1:</u> Balance, posture, and positioning	1. Maintaining balance and upright posture; 4. Positioning self to engage in activity
<u>Dimension 2:</u> Maintenance and change of object position	8. Using sporting and activity equipment; 9. Obtaining objects; 10. Transporting objects from place to place; 11. Managing personal school equipment; 12. Manipulating and using tools and materials; 13. Using writing and drawing implements	<u>Dimension 2:</u> Transportation of self and objects	3. Coordinating a response to sensory input; 5. Remembering a movement sequence/ strategy; 6. Moving from one position/place to another; 7. Avoiding obstacles/ preventing problems; 10. Transporting objects from place to place
<u>Dimension 3:</u> Management and maintenance of physical engagement	2. Regulating physical tension; 3. Coordinating a response to sensory input; 14. Sharing space interactively with others; 16. Seeking out movement challenges; 17. Persevering in movement tasks; 18. Working within physical limits	<u>Dimension 3:</u> Manipulation and use of objects and tools	8. Using sporting and activity equipment; 9. Obtaining objects; 11. Managing personal school equipment; 12. Manipulating and using tools and materials; 13. Using writing and drawing implements
		<u>Dimension 4:</u> Communicative/ interactive skills	2. Regulating physical tension; 14. Sharing space interactively with others; 15. Self-expression and communication
		<u>Dimension 5:</u> Performance sustainment	16. Seeking out movement challenges; 17. Persevering in movement tasks; 18. Working within physical limits; 19. Completing tasks involving strenuous movement

To evaluate the fit of items to these respective dimensional allocations, the multidimensional random coefficients multinomial logit model (MRCML) (Adams, Wilson & Wang, 1997) was applied, using ACER ConQuest IRT software (Adams, Wu, & Wilson, 2015). The MRCML analyses dimensionality of partial-credit assessment items, providing each item with a score or weight for the dimension(s) proposed to be operating. Results from the two analyses, in terms of item infit scores, are provided in Table 34, alongside the original unidimensional result. Appendix I provides the statistical output files for the five-dimensional analysis.

Table 34 *Results of Multidimensional IRT Analysis of the Main Study Items*

Item and description		Infit mean-square		
		1-dim.	3-dim.	5-dim.
1	Maintaining balance and upright posture	1.43	1.35	1.14
2	Regulating physical tension	1.36	1.36	1.12
3	Coordinating a response to sensory input	1.08	1.01	1.14
4	Positioning self to engage in physical activity	0.94	0.87	0.84
5	Remembering a movement sequence or task	0.88	0.84	0.96
6	Moving from one position/place to another	0.79	0.76	0.85
7	Using movement to avoid obstacles or prevent problems occurring	1.07	1.03	1.15
8	Using sporting or activity equipment	0.75	0.86	0.85
9	Obtaining objects	1.05	1.20	1.18
10	Transporting objects from one place to place	0.80	0.86	0.91
11	Managing personal equipment	0.82	0.89	0.88
12	Manipulating tools and materials	0.79	0.87	0.89
13	Using writing and drawing implements	1.23	1.35	1.32
14	Sharing space interactively with others	0.96	0.97	0.84
15	Using movement for communication and self-expression	1.33	1.29	1.07
16	Seeking out movement challenges	0.90	0.90	1.07
17	Persevering in movement tasks	0.79	0.79	0.88
18	Working within physical limits	1.00	1.00	1.12
19	Completing tasks involving strenuous movement	1.02	0.98	1.06

Table 34 indicates that the 3-dimensional allocation of items did not sufficiently improve item fit, whereas the allocation of items to five dimensions improved the fit of problematic items 1, 2, and 15. It also resulted in a slight worsening of fit for handwriting Item 13, though not to a significant level. On the basis of these results, a 3-dimensional allocation was not supported by results, but a case for a five-dimensional allocation could be made on the basis of improved item fit, and in terms of improving the usefulness of results to classroom-based end-users.

Chapter Summary

The study had established a unidimensional scale of goal-directed movement, which was positive in terms of fit to the Rasch model. At the same time, as noted in Chapter Three, scholarly opinion commonly divides the human movement domain variously, from the simplest division into body (gross-motor/ mobility) and hand (fine-motor/ object use) skill (Bernstein, 1991), to Reed's (1982) identification of eight human movement action systems, extending to appetitive and semantic aspects, and the ICF's (WHO, 2001) categorisation that includes task-related, or activity and participation goals in the movement description. These divisions recognise different profiles of ability in the population (Bernstein), and the usefulness of categorisation to targeted intervention in this complex, extensive domain (Campbell, 2012; Shumway-Cook & Woollacott, 2012). Measurement theory, in addition, does not consider such division to jeopardise unidimensionality, but potentially to more deeply explicate the latent trait (Wu & Adams, 2007).

Underfit means an item has a different discrimination to the other items, not necessarily that its discriminating power is worse, as the mean-square fit statistic rates the slope of one test item against all other item slopes, rather than scores the quality of discrimination of slopes (Wu et al., 2016). Underfit generally indicates the incorporation of other elements into the requirements of an item, resulting in deviation from the model's assumption of

unidimensionality. The item-steps outlined in items 1, 2, and 15 above are consistent with this situation, as they express complex skills, or functional skills necessarily taking place in combination. Rather than tapping different skills it is more likely correlated skills are being called on, in which case addressing these as separate dimensions is not appropriate (Wu et al., 2016). The multidimensional analysis conducted in this chapter has demonstrated an improvement to the infit statistic of Items 1, 2, and 15 when loaded onto five dimensions that express classroom-important aspects of the domain, aspects that are also noted in the research and assessment literature. In response to the second concern of the first research question, which asked about the extent of unidimensionality of the items, this chapter has confirmed unidimensionality, but also value in clustering the 19 items onto the five sub-dimensions of balance and postural control, transportation of self and objects, manipulation and use of objects and tools, self-expression and social interaction, and fitness, endurance and motivation. When the 19 items of this scale were loaded onto their respective dimensions, multidimensional IRT analysis supported the result in a better fit of all items to the Rasch model, and particularly Items 1, 2, and 15, than an alternative three-dimensional possibility and the original unidimensional analysis.

The next chapter summarises the results of further scale development by a Delphi panel of expert occupational therapy clinicians, who drew upon the suggestions of the multidimensional analysis and worked within the Bookmark approach to standard-setting, to provide standards for the five-dimensional scale. Following that, in Chapter Nine an additional analysis of the results of the main study will be reported in the form of a cross-tabulation, to identify the impact of severity and type of motor impairment on scale performance. This will respond to the final research question which asked concerning this.

Chapter Eight: Standard Setting Results

This chapter reports the results of the Delphi standard-setting study that responded to the third research question concerning stages of learning for the progression, and report format recommendations for different members of the student's learning support team. The results from this work then enabled response to the fourth research question, which concerned impact of impairment severity on scale performance. This latter interest arose from indications in motor learning and rehabilitation literature that “enormous amounts of practice and extensive time periods” are needed to achieve motor skill, alongside the tendency, also noted, that these opportunities are frequently reduced for children with motor impairments (Gordon & Magill, 2012, p.151; see also Adolph & Berger, 2006; Carr & Shepherd, 2006; Effgen & Chan, 2010). The results from the demographic questionnaire that gathered information about student impairment severity were also used to address this question, to be reported in Chapter Nine. The current chapter proceeds firstly with a summary of demographic information of panel members, then reports the results from the three Delphi rounds.

Delphi Expert Panel

Recruitment, Sample Composition and Retention

Six participants were considered for inclusion in the study, from an estimated pool of approximately 150-200 sufficiently qualified Victorian occupational therapists (AIHW, 2014). One had insufficient experience (less than three years), leaving five considered appropriate, who all agreed to participate – two who self-selected in response to advertisement via the OT association e-bulletin and paediatric listserv VICPOTS (Victorian paediatric occupational therapists), and three who were personally approached at paediatric

professional development days and network meetings. All participants completed the full set of rounds.

Demographic information

Panellist information was sought, firstly regarding years of involvement in paediatric occupational therapy and secondly regarding expertise with school-aged children with movement disorders. Table 35 summarises this information.

Table 35 *Delphi Panellist Experience*

	Graduation year	Highest qualification in cognate area	Paediatric experience (yrs.)
Panellist 1	1995	Bachelor	20
Panellist 2	1988	Postgraduate	28
Panellist 3	1989	Postgraduate	25
Panellist 4	1998	Bachelor	12
Panellist 5	1979	Postgraduate	30

In relation to expertise, panellists were asked to provide their areas of current and past practice, and nature of work supporting motor skill development for school-aged children with motor impairments. Results are shown in Table 36, with the questions provided in Appendix L) –

Table 36 *Panellist Expertise in School-based Paediatric Occupational Therapy*

Practice details:	Panellist 1	Panellist 2	Panellist 3	Panellist 4	Panellist 5
<i>Areas of work:</i>					
School	Yes	Yes	Yes	Yes	Yes
Hospital setting	Yes	Yes	-	Yes	-
Community Health	Yes	-	Yes	Yes	-
Non-gov't	Yes	-	Yes		Yes
Private Practice	Yes	Yes		Yes	
Other	-	Special & mainstream schools, hospital-based paediatric rehab; ECIS	ECIS >10yrs; have worked in specialist and mainstream settings; have set up two paediatric OT services	-	ECIS; DHS
<i>Nature of work:</i>					
Working with students (in/out of classroom) on movement-related issues	Yes	Yes	Yes	Yes	Yes
Advising/ collaborating with teachers/ education support staff	Yes	Yes	-	Yes	Yes
Teaching/ research/ writing	Yes	-	-	-	-
Involvement in organisations/ special interest networks/		Yes		Yes	Yes
Other	Currently completing post-graduate qualification	Supervision of a team of therapists	Part consultant, part work with teachers	-	-

In summary, panellists were highly experienced therapists with past and current experience in therapy provision for students with motor impairments, hence, were considered competent to undertake this complex, standard-setting work.

Delphi Rounds

The survey questions built on one another across the three rounds, necessitating both refinement of previous opinion to improve consensus, as well as working forwards from the decision(s) previously made. The distinctive work of each round was as follows –

1. Round 1 – confirming aspects, or dimensions and categorisation of the 19 items.
2. Round 2 – confirming the continuum, or order, of difficulty of the item-steps for each dimension; suggesting additional items for gaps; setting cut points along each continuum indicating major shifts in difficulty; and providing performance level descriptions of the nature of the skills operating at each level.
3. Round 3 – further standard-setting consensus-building; considerations of reporting formats for different stakeholder groups.

Round 1 – Confirmation of the Five Dimensions and Categorisation of Items

Panellists were provided with the five dimensions and the categorisation of items that multidimensional analysis had confirmed as providing best fit to the Rasch model. To support their connection with this prior work, they were invited to comment and suggest alternatives. Table 37 provides the results of their considerations.

Table 37 *Round 1 Tasks and Results*

Task:	Consensus position reached:	Other comments:
Confirmation of dimensions	All panellists agreed on the five aspects, or dimensions	Two comments, confirming the appropriateness and usefulness of the dimensions
Confirmation of categorisation of items	Agreement with placement of 18 of the 19 items. Item 8 (Using sporting and activity equipment) received equal recommendation for two dimensions – 3 (Manipulation and use of objects and tools), and 5 (Performance sustainment)	One comment on the possible addition of an item on cognition in motor performance - <i>“I think that cognition is a major component in motor development, in relation to attention, motivation, planning, sequencing and checking of performance.”</i>

In relation to the lack of consensus on Item 8’s placement, researcher response placed it in both dimensions for decision-making in the next round. In relation to the suggestion to add a cognitive item, researcher response noted the controversy in the literature on the role of cognition in motor learning, and whether dynamic (systems) or hierarchical (cognitive) explanations better express human movement proficiency (Latash & Anson, 1996; see Chapter Three on Movement). As noted in Chapter Three of this dissertation, the perspective of this study is the “representative redescription” proposal of Karmiloff-Smith (1994, p.693), that confirms both dynamic and hierarchical approaches, but cognitive internal reorganisation driving motor skill advance in discrete, non-repetitive, complex movements, such as those prevalent in the classroom. Consequently, cognition was built into the proficiency steps of the items in various ways, rather than being depicted as a discrete item. Hence, in response to the suggestion to add a cognition item, researcher suggested that panellists complete Round 2, noting the role of cognition into the unfolding description of skills (the item-steps, or rubrics, for each item).

Round 2 – Confirming Item-Step Order, Cut Points, and Level Descriptions

In the second round, panellists were provided with five tables, containing the items categorised from Round One, but now ‘broken out’ to the item steps, provided in ascending order according to increasing proficiency based on the IRM calibration of results of Study 1. For example, Items #1 and #4 each consisted of four proficiency steps of increasing difficulty, making up, when brought together, a single 8-step progression in the *Balance, Postural Control and Positioning* category – see Table 38 – Dimension 1 Skill Progression, noting that step numbering was not provided to panellists (the full set of tables are provided in Appendix M). These tables of items included the addition of Item 8 into two Dimensions – 3 and 5.

Table 38 *Dimension 1 Skill Progression*

Rank	1. BALANCE, POSTURAL CONTROL, AND POSITIONING
order	#1 – Maintaining balance and upright posture; #4 – Positioning self to engage in activity
4.4	<i>HARDEST</i> Anticipates and adjusts position throughout activity to support functioning
1.4	Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects; leans in to navigate curves when riding a bike)
1.3	Maintains balance with attention directed elsewhere (e.g., climbs stairs in a crowd)
4.3	Positions self to commence activity (e.g., moves into position to use objects/ tools)
1.2	Relies on strategies/cues to maintain stability (e.g., ‘feet flat, bottom back to sit up straight’)
4.2	Assists in being positioned for activity engagement (e.g., leans/ moves in)
4.1	Responds to activity when positioned before it (e.g., attempts to reach)
1.1	<i>EASIEST</i> Reacts to lost balance (e.g., startles; rights head; extends arms)

Task 1: Confirming item-step order. The steps were provided in the rank order established using the difficulty estimates of the multidimensional analysis, and panellists were invited to comment and suggest any alterations to this order, or additions to the skill set.

Dimension 1: Balance, postural control, and positioning. Consensus was reached (4 out of 5 panellists) on the ordering of steps, with the following suggestions made re Dimension 1:

- ‘Reacts to lost balance’ was suggested to be broken into two steps, to more accurately reflect the different levels of skill indicated by the examples (‘startles’ expressing this skill at the beginning level, and ‘rights head, extends arms’, expressing it with greater intentionality and control).
- Four additional steps were suggested – two at the beginning of the progression for students requiring maximum postural support via the use of equipment and adaptations, a further step to express an intermittent or occasional ability to maintain postural stability, and finally, a step recognising balance capability during activity, provided items or tasks are static or table-top.

These suggestions were added to Dimension 1, producing 13-step category for further panellist consideration (see Table 39).

Table 39 *Expanded Dimension 1 – Balance, Postural Control, and Positioning*

Item	Description
4.4	Anticipates and adjusts position throughout activity to support efficient functioning
1.4	Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)
1.3	Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)
NEW	Adjusts position throughout activity to support efficient functioning in relation to static objects (e.g., table-top activities)
NEW	Corrects lost seated balance (e.g., able to right self and maintain position when knocked off balance)
4.3	Positions self to commence activity (e.g., moves into position to use tools)
NEW	Maintains balance or postural control in selected environments or selected times only (e.g., while completing static task/ table task; when sitting on chair, at start of day)
1.2	Relies on strategies or cues to maintain stable posture (e.g., “feet flat, bottom back to sit up straight”)
... continued next page	

Item	Description
4.2	Assists in being positioned for activity engagement (e.g., leans/ moves in)
4.1	Responds to activity when positioned in front of it (e.g., shows interest; attempts to reach)
1.1	Responds to lost balance (e.g., startles; rights head; extends arms)
NEW	Maintains head in upright position when placed in seated position with trunk support; relies on equipment or adaptations to maintain stable posture and engage in learning activities without tiring
NEW	Reliant on full-support seating to achieve upright head and use of eyes (e.g., head rest, footplates, side support seat belt)

Dimension 2: Transportation of self and objects. Panellists were in consensus agreement with the order of progression of item proficiency steps for this dimension.

Dimension 3: Manipulation and use of objects, tools and equipment.

Panellists were in consensus agreement with the order of progression of item proficiency steps for this dimension, though had concerns with the wording of Item 13 (Using writing and drawing implements), noting “slippage” between skills (13.3 and 13.4) and tasks (13.1 and 13.2). Another panellist considered handwriting an OT specialist area with many assessments already developed, and that it was “better considered separately, as a very refined skill.” Researcher reflection identified handwriting as an important classroom motor skill, and poor handwriting as one of the most common reasons for referral of school-aged children to occupational therapy (Overvelde & Hulstijn, 2011). However, it was also noted that while there are many handwriting assessments, a 2011 review of twelve such commonly used and standardised tests demonstrated none with satisfactory psychometric properties or feasibility (Hartingsveldt, de Groot, Aarts, & Nijhuis-Van der Sanden, 2011). Retention of a handwriting item in this assessment was therefore proposed to panellists for follow-up consideration, as an important aspect of a classroom-based motor assessment, with results useful to the work of teachers and therapists collaborating to improve handwriting for a student. To support this, alternative skill descriptions were proposed for consideration in response to the problem of slippage between tasks and skills. Table 40 sets out these

proposed changes, in ascending order according to difficulty, drawn from panellists' wording in level statements, and Fitts' and Posner's (1967) cognitive, associative and autonomous motor learning stages. These were tabled for consideration in Round 3.

Table 40 *Deliberations over Handwriting Item 13*

Original Item 13:	New Item 13:
13.4 Maintains legible and fluent handwriting in demanding or novel writing tasks (e.g., when writing at speed or for long periods; when writing with different sizes/ types of implements)	13.4: Writes fluently and automatically while engaged in another task (e.g., writes while simultaneously processing auditory information and cognitively composing)
13.3 Achieves legible handwriting when writing slowly in familiar writing tasks (e.g., writing own name; reproducing letters and numbers)	13.3: Independently adjusts and readjusts movements to correct writing/drawing errors (e.g., repeats attempts using different positions/ grasps to improve neatness/ position of letters on line)
13.2 Copies or traces over patterns or shapes	13.2: Relies on cues/prompts to direct attention to task requirements and/or verbalize learned movement strategies in pre-writing tasks (e.g., verbalises direction of movement and strategy for copying/tracing over shapes)
13.1 Scribbles or makes marks on paper	13.1 Demonstrates a general idea of the movements required for handwriting (e.g., scribbles, makes marks on paper)

Dimension 4: Communicative/ interactive skills. Panellists were in consensus agreement with the order of progression of item proficiency steps for this dimension.

Dimension 5: Performance sustainment. Panellists were in consensus agreement with the order of progression of item proficiency steps for this dimension, except for Item 8, which had been placed here as well as in Dimension 3, following panellist consideration from the first round. Its content now appeared inconsistent with this Dimension's focus on fitness and motivation as, at the item-step level, it related more to equipment handling generally.

Therefore, it was removed from this category, and retained only in Category 3.

Task 2: Setting cut-points and providing performance level descriptions. Panellists perceived shifts in skill across the progressions, with some differences in placement of cut points and levels. Results are set out in Figures 39 to 43, with divisions receiving majority agreement (3-4 panellists) in the left-hand column, and any alternatives agreed upon by up to two panellists in the right-hand column. Item-steps are again placed in ascending order.

Majority/ logits	Item-steps in ascending order of difficulty	1-2 agreed/ logits
	Anticipates and adjusts position throughout activity to support efficient functioning	2.84
2.75	Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)	2.75
0.82	Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)	0.82
	PANELLIST SUGGESTION: Adjusts position throughout activity to support efficient functioning in relation to static objects (e.g., table-top activities)	
	PANELLIST SUGGESTION: Corrects lost seated balance (e.g., rights self and maintains position if knocked)	
0.32	Positions self to commence activity (e.g., moves into position to enable use of objects/ tools)	0.32
	PANELLIST SUGGESTION: Maintains balance or postural control in selected environments or selected times only (e.g., while completing static task/ table task; when sitting on chair, at start of day)	
-0.72	Relies on strategies or cues to maintain stable posture (e.g., “feet flat, bottom back to sit up straight”)	
-1.11	Assists in being positioned for activity engagement (e.g., leans/ moves in)	
-3.11	Reacts to lost balance (e.g., rights head; extends arms)	
	Responds to activity when positioned in front of it (e.g., shows interest, attempts to reach)	
	PANELLIST SUGGESTION: Maintains head in upright position when placed in seated position with trunk support; relies on equipment/adaptions to maintain stable posture and engage in activities without tiring	
	PANELLIST SUGGESTION: Reliant on full-support seating to achieve upright head and use of eyes (e.g., head rest, footplates, side support seat belt)	

Figure 39. Delphi cut-points for Dimension 1: Balance, posture, and positioning

The threshold parameters supported the majority four-level recommendation for the location of the cut-offs, as did the substantive skill change between these levels, shifting from movement in response to others, to greater proactive confidence in managing balancing and positioning needs. Note: The five additional suggestions to fill perceived gaps in the set of skills for this dimension were notionally placed according to panellist opinion.

Majority/ logits	Item-steps in ascending order of difficulty	1-2 agreed/ logits
	Masters fluency and control when moving or repositioning quickly (e.g., changes direction smoothly in response to demands of a game; negotiates crowded hallways without difficulty; fluently achieves multi-step tasks)	
	Adapts or adjusts movement in response to changing sensory input (e.g., immediately tightens hold on unexpectedly heavy object to prevent it from falling; successfully catches a ball thrown at a suddenly faster speed)	
	Adapts a movement sequence to suit new circumstances (e.g., changes strategy to reach accurately at different speeds; alters gait quickly in response to suddenly changed conditions; combines sequences/ strategies to achieve more of a task)	2.89 →
← 2.73	Transports objects even while engaged on other aspects of activity (e.g., while manipulating objects; while talking; in crowded situations)	2.73 →
2.68	Modifies movement to avoid obstacles that have proved difficult in the past, or that have suddenly arisen (e.g., slows or focuses attention to avoid a trip hazard)	
← 1.08	Practices moving under different sensory conditions (e.g. in time to a rhythm; in reduced light; at different speeds; across different surfaces)	
← -0.21	Concentrates to achieve transport of self and object(s)	-0.21 →
	Focuses on the sensory aspects of movement in order to achieve routine movement tasks (e.g., watches hands to reach accurately; attends to positioning of feet while climbing stairs)	-0.53 →
	Focuses, or attends consciously, in order to reposition self during routine tasks (e.g., attends consciously to placement of feet; focuses on the movement requirements of the next step of task)	
	Repeats a simple movement sequence in imitation or from memory (e.g., to sit up straight, walk in walker, remove/put on jumper)	-0.73 →
← -0.74	Attempts to avoid obstacles in familiar settings (e.g., gives wide berth; stops to wait for another to pass)	-0.74 →
← -2.37	Cooperates in tasks involving transport of routine items	
	Cooperates with the next step of a routine movement (e.g. turns towards, lifts arms)	-2.75 →
← -2.92	Reacts when moved around obstacles and through narrow spaces (e.g., holds on; leans in)	-2.92 →
← -4.41	Shows awareness of the sensory aspects of objects, environment, or movement (e.g., shows preference for different textures, temperatures, or body positions)	
	Shows awareness of being re-positioned or moved (e.g., orients or turns toward direction of travel, or reaches to touch surfaces/objects while passing)	

Figure 40. Delphi cut-points for Dimension 2: Transportation of self and objects

The threshold parameters supported the majority five-level recommendation for the location of the cut-offs; however, the minority view had selected the more significant ability shift for the final level (from 2.73 to 2.89), indicated substantively by a new ability to achieve movement goals in novel and dynamically changing situations. Therefore, this break-point was tabled for further consensus consideration in Round 3.

Majority/ logits	Item-steps in ascending order of difficulty	1-2 agreed/ logits
	Maintains legible and fluent handwriting in demanding or novel writing tasks (e.g., when writing at speed or for long periods; when writing with different sizes/ types of writing implements)	
3.61	Manipulates and uses tools and materials with appropriate strength and control, while attending to other aspects of task (e.g., moves and stabilises paper while writing)	
3.31	Adjusts movement response to meet requirements of equipment or activity (e.g., changes movement to keep time with different rhythms)	3.31
	Adapts or adjusts strategies for obtaining objects to suit changing requirements or prevent problems (e.g., alters grip to secure objects)	2.65
	Achieves legible handwriting when writing slowly and in relation to familiar writing tasks (e.g., when writing own name)	
2.12	Uses a range of movement strategies to manage personal school equipment (e.g., uses different body parts to stabilise objects)	
0.68	Copies or traces over patterns and shapes	
0.56	Focuses or slows to use tools and materials with appropriate strength and control (e.g. concentrates to operate joystick on motorised wheelchair; slows to use mouse or keyboard; focuses to hold pen/ pencil lightly and press gently when writing)	
-0.44	Varies strategies for obtaining objects (e.g., one-handed or two-handed methods)	
	Uses equipment in familiar activities (e.g., passes items to a partner in a routine task)	
	Achieves a component of equipment handling (e.g., holds backpack while another closes it)	-0.94
-2.51	Scribbles, or makes marks on the paper	-2.51
-3.75	Responds to sensory properties of tools and materials (e.g. tightens and loosens grip, moves fingers over surface)	
	Uses a familiar strategy or method for obtaining objects (e.g., the same raking or swiping strategy for bringing all objects to self)	
	Attends to properties or functions of equipment (e.g., responds upon touching; turns towards; pushes away)	
	Attends to equipment when placed in hand or nearby (e.g. stills body; holds briefly)	

Figure 41. Delphi cut-points for Dimension 3: Manipulation of objects and tools

Decisions about cut points supported the five levels of the majority view, noting that the minority view of four levels essentially combined levels 2 and 3. There was a difference in placement of the lowest step of handwriting Item 13, with reasonable threshold shifts existing for either option. The earlier noted panellist recommendations for changed wording for this item, to focus more on motor skill than output, will likely result in a different placement of this item-step. This is a recommendation for follow-up work.

Majority/ logits	Item-steps in ascending order of difficulty	1-2 agreed/ logits
	Regulates physical tension and response during activities with changing energy demands (e.g., calms for quiet activity, following activity with raised energy)	2.94
	Extends and adapts repertoire of gestures/ facial expressions to suit different needs or audiences (e.g., catches a person's eye and then directs their gaze; exaggerates or alters gestures or facial expressions to imitate others or to convey more nuanced meanings)	2.89
2.24	Cooperates with others to share the space (e.g., moves responsively; moves over to share desk space)	
1.22	Uses a strategy to manage physical tension during activity (e.g., requests a break, or calms by linking breathing to a slow, repetitive movement)	
	Manages own needs in shared space (e.g., follows instructions for avoiding bumping into others; experiments with how much room is needed to pass by another safely)	0.26
-0.2	Uses a consistent repertoire of gestures/ facial expressions to establish meaning	-0.2
-3.07	Reacts to stimulation or emotion (e.g., changes level of engagement, changes breathing rate)	
	Uses gestures/ facial expressions interpretable to familiar others	-3.19
	Reacts or attends when others come close	-3.74

Figure 42. Delphi cut-points for Dimension 4: Communicative/ interactive skills

The threshold parameters supported the majority three-level recommendation for the location of the cut-offs. The minority five-level view had single item-steps in two of the levels, with one panellist noting a difficulty combining skills of self-regulation and interaction in one dimension – “Finding this section difficult to order, as the items are interchanged between physical interaction with objects and social responses to people.” The researcher noted the

common physical aspect in both these skills, which, when considered together, would provide both individual and interactional intervention options to teachers. It was also noted that the research findings had highlighted difficulties with tension-regulation in children with ADHD, affecting their reciprocal engagement with others and ability to recognise social cues (Renk et al., 2011) and that attending to the exercise and energy-output needs of children with ASD supported more pro-social behaviour (Sowa & Meulenbroek, 2012).

Majority/ logits	Item-steps in ascending order of difficulty	1-2 agreed/ logits
	Completes strenuous movement activities comfortably (e.g., at required speed; while maintaining focus on other aspects of task)	
	Adapts movement strategies in response to more challenging settings (e.g., devises a new strategy for carrying objects over greater distances; uses an alternative way to travel across a different ground surface)	
4.41	With planning, achieves maximum involvement possible within physical limits (e.g., conserves energy by combining steps; sits where possible)	
2.99	Creates opportunities to move from classroom activities (e.g., experiments with different ways to mobilise around the classroom; finds novel movement opportunities within routine tasks)	2.99
	Manages a strenuous activity at slowed pace, or with rest periods	2.67
	Initiates an attempt at new or more difficult aspects of tasks (e.g., exerts self to complete task; attempts task on own)	2.47
	Adheres to rules regarding level of involvement and activity choice (e.g., checks with adult before engaging in new activity)	2.04
0.28	Engages in occasional strenuous movement during activity (e.g., during stretching exercises; while moving to music)	
-0.36	Attempts greater physical involvement in classroom tasks (e.g., puts hand up to block or reduce helper involvement)	-0.36
	Completes tasks within movement capacity with prompting or support (e.g., takes items from backpack when instructed)	-1.09
	Maintains energy output for duration of simple routine tasks (e.g., for packing up; for putting away; to move between activities)	-1.82
-2.3	Relies on direct instruction to regulate involvement (e.g., takes a break when directed to do so)	-2.3
-3.71	Participates in movements easily achieved, or that provide immediate positive outcome (e.g., moves towards desired object or person)	-3.71
	Shows awareness of activities nearby (e.g., lifts head; vocalises)	-5.19

Figure 43. Delphi cut-points for Dimension 5: Performance sustainment

Decisions about level cut-offs supported the majority regarding placement for first and last levels, but consideration of the content of skills in between suggested three levels might be operating rather than two, as was recommended by two panellists, with the level breaks coming between ‘Completes tasks within movement capacity with prompting or support’ (threshold parameter -1.09) and ‘Attempts greater physical involvement in classroom tasks’ (threshold parameter -0.36); and ‘Adheres to rules regarding level of involvement’ (threshold parameter 2.04) and ‘Initiates attempt at new or more difficult aspects’ (threshold parameter 2.47). This five-level dimension would support responsive skills at the second level, proactive, rule-following skills at the third, greater determination/ perseverance at the fourth, and inventiveness and high fitness at the final level. This proposal was tabled for Round 3.

Concluding the Delphi panellist work of cutting the five dimensions into levels, in Round 2, majority agreement was gained for the levels of Dimensions 1, 3, and 4. A minor change to the placement of the final cutpoint for Dimension 2, and a proposal for five levels for Dimension 5 was tabled for consensus consideration in the final Delphi round.

The second part of Round 2 required panellists to provide descriptions for each of the levels of the five dimensions. Four of the five panellists completed this work. Tables 41 to 45 set out the descriptions that were provided, again, in ascending order by difficulty.

Table 41 *Delphi Level Statements for Dimension 1: Balance, Posture, and Positioning*

Panellist	Level statements
1	4 Learning to maintain balance during movement activities; 3 Learning to position self and maintain posture in seated (or standing) position; 2 Learning to be responsive to physical input and verbal cues; 1 Displays protective responses
2	4 Adjusts body to demands of changes to external environment; 3 Adapts position to respond to task demands; 2 Relies on individualised external conditions to maintain body during activities; 1 Relies on direct and ongoing support to use body to engage with activities
3	2 Higher level dynamic balance, evidence of skill refinement; 1 More basic hierarchy starting from reflexive to only requiring verbal cues; linking of movement with activity; needs postural stability before task attempt
4	4 Mastery and sophistication of skill; 3 More active and higher-level skill; includes problem solving; 2 Response but still dependent on others; 1 Reflexes; sensory
5	<i>Did not complete this task</i>

Table 42 *Delphi Level Statements for Dimension 2: Transportation of Self and Objects*

Panellist	Level statements
1	5 Functional and competent transportation of self and objects 4 Demonstrates problem-solving during movement and when obtaining objects 3 Learning to focus and think about/ plan movement in response to objects 2 Learning to respond to objects in the environment 1 Learning about objects/movement in environment
2	5 Makes modifications; problem solves 4 Transports self and / or objects within diverse environments 3 Transports self and /or objects with modifications or adjustments to the environment or task 2 Participates without assistance in aspects or parts of transport tasks 1 Requires support to participate in transport tasks
3	5 Mastery and sophistication of skills 4 Higher level skills, multiple levels of coordination required to be aligned with cognitive attention; 3 Adjusting to the environment 2 Learning to focus on self, a practice or refining phase 1 These skills are reliant on proximity or support of an adult, movement skills emerging
4	5 Makes modifications, problem-solves 4 Active and higher-level skills; increased range 3 More actively involved but with limited range 2 Responds, but still dependent on others 1 Quite passive; sensory

Table 43 *Delphi Level Statements for Dimension 3: Manipulation of Objects and Tools*

Panellist	Level statements
1	5 Able to transfer and generalise manipulation skills 4 Calibrates force, rhythm and timing when using objects 3 Cooperates with others to complete a task involving equipment, shows pre-writing visual-motor skills 2 Explores objects 1 Responds to equipment
2	5 Developing or achieved automaticity in manipulation of objects 4 Uses increasingly diverse range of movements to manipulate objects 3 Applies some skill in manipulating objects, commences using writing tools 2 Moves to participate in a routine 1 Interacts with objects in the environment
3	4 Learning a higher level of coordination, motor skills linked to cognition and language 3 Learning more sophisticated skills – bilateral coordination and sequencing through each step of task 2 Sequences simple movements independently 1 Learning to modify and be responsive in movement to meet requirement of task, promote best effort
4	5 Mastery and sophistication of skills 4 Active; increased control of motor patterns and grading of movement; adaptation 3 Active engagement with familiar motor patterns 2 Response; exploratory 1 Reflexive; sensory

Table 44 *Delphi Level Statements for Dimension 4: Communicative/ Interactive Skills*

Panellist	Level statements
1	3 Mature and fluid responses to social situations and ability to regulate self 2 Learning to co-operate and manage own feelings 1 Developing ability to respond to others and environment, and awareness of self-expression for use in communication
2	3 Regulates self in relation to subtle changes in environment including social interactions with others 2 Relies on others to interpret meaning and assist in regulation; relies on cues or assistance to regulate self 1 Demonstrates awareness of external environment
3	<i>Missed this dimension</i>
4	5 Achieves self-regulation of bodily tension 4 Interaction with others; makes modifications 3 Active, higher level skills; increased range 2 More actively involved but still limited range 1 Sensory reflexes; responds, but dependent on others

Table 45 *Delphi Level Statements for Dimension 5: Performance Sustainment*

Panellist	Level statements
1	6 Demonstrates ability to problem-solve in order to engage in physical activity 5 Learning to participate in physical activity with support 4 Learning to express self physically with some support 3 Developing endurance for physical tasks 2 Beginning to participate in movement activities 1 Responsive to environment
2	4 Performs at a level of skill and endurance appropriate to the task 3 Requires modification to the task or environment to perform the task at an appropriate level of skill and endurance 2 Performs portions or aspects of the task at an appropriate level of skill and endurance 1 Relies on assistance to participate in portions or aspects of the task
3	4 Refines movement in context of environmental requirements, achieves more demanding tasks from an exertion perspective 3 Initiates and tries variations; learns about force and exertion during movement, about bilateral coordination and use of environmental supports or enhancers 2 Learns basic awareness of movement in relation to motor activity engagement or completion, 1 Needing adult prompt in regulating movement
4	4 Mastery and sophistication of skills 3 Initiates modifications; problem solves; increased range 2 Makes modifications to routine movement; problem solves 1 Reflex; sensory; dependent on others

These level statements were analysed by the researcher between rounds and a single set of statements produced for each dimension, incorporating panellist suggestions. This was returned to panellists as a proposal for further consensus consideration in the final round. Tables 46 to 50 set out this proposed set, noting the inclusion of the additional balance items in Dimension 1, and the changed wording for the handwriting Item 13 in Dimension 3.

Table 46 *Levels of Dimension 1: Balance, Posture, and Positioning*

Item	Description	Level and Level Statement
13	Anticipates and adjusts position throughout activity to support efficient functioning in relation to dynamic objects (e.g., during sport/ ball games)	LEVEL 4: The student smoothly adjusts and readjusts body position to maintain dynamic balance during movement activities, or in response to changing activity requirements. He/she automatically applies a range of strategies to maintain or regain balance and stability in unpredictable or dynamically changing situations
12	Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)	
11	Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)	LEVEL 3: The student adjusts/ corrects posture and position for optimal task engagement and may responsively correct lost seated balance if knocked. In mobilising, he/she can maintain balance with attention directed elsewhere
10	Adjusts position throughout activity to support efficient functioning in relation-to static objects (e.g., table-top activities)	
9	Corrects lost seated balance (e.g., able to right self and maintain position when knocked off balance)	
8	Positions self to commence activity (e.g., moves into position to enable use of objects/ tools)	
7	Maintains balance or postural control in selected environments or selected times only (e.g., while completing static task/ table task; when sitting on chair, at start of day)	LEVEL 2: The student draws on and learns responsiveness to individualised cues and contexts to actively position self and commence activity, and with concentration, can maintain balance and postural control at selected times, or during static/ table tasks and activities
6	Relies on strategies or cues to maintain stable posture (e.g., “feet flat, bottom back to sit up straight”)	
5	Assists in being positioned for activity engagement (e.g., leans/ moves in)	
4	Responds to activity when positioned in front of it (e.g., shows interest; attempts to reach)	LEVEL 1: The student attempts to maintain upright head position in seated positions, and makes reflexive, or sensory responses to loss of balance. With support to achieve initial postural stability, he/she engages in learning activities placed before him/her, relying on direct and ongoing support to maintain this without tiring (e.g., supported seating, positioning aids, modifications to task/ environment)
3	Reactively responds (involuntary) to lost balance (e.g., startles)	
2	Maintains head in upright position when placed in seated position with trunk support; relies on equipment or adaptations to maintain stable posture and engage in learning activities without tiring	
1	Reliant on full-support seating to achieve upright head and use of eyes (e.g., head rest, footplates, side support seat belt)	

Table 47 *Levels of Dimension 2: Transportation of Self and Objects*

Item	Description	Level and Level Statement
16	Masters fluency and control when moving or repositioning quickly (e.g., changes direction smoothly in response to demands of a game; negotiates crowded hallways without difficulty)	LEVEL 5: The student transports self and/or objects effortlessly and fluently within diverse and dynamically changing environments. He/she achieves multiple additional activity goals concurrently, requiring cognitive attention and dynamic adjustment to unfolding/ unpredictable situations
15	Manages performance involving more than one demand (e.g., talks while navigating obstacles, or adjusts focus between working on own and with a partner)	
14	Adapts a movement sequence to suit new circumstances (e.g., changes strategy to reach accurately at different speeds; alters gait quickly in response to suddenly changed conditions; combines sequences/ strategies to achieve more of a task)	
13	Transports objects even while engaged on other aspects of activity (e.g., while manipulating objects; while talking; in crowded situations)	
12	Modifies movement to avoid obstacles that have proved difficult in the past, or that have suddenly arisen (e.g., slows to avoid a trip hazard)	LEVEL 4: The student applies problem-solving skills in response to unexpected task/activity requirements to continue to safely achieve transport goals. He/she successfully transports objects in more complex, non-routine tasks. Repetition and practice results in increasingly successful outcomes in terms of efficiency and speed
11	Practices moving under different sensory conditions (e.g. in time to a rhythm; in reduced light; at different speeds; across different surfaces)	
10	Concentrates to achieve transport of self and object(s)	
9	Focuses on the sensation of moving to achieve routine movement tasks (e.g., watches hands to reach accurately; attends to the feel of feet while walking)	LEVEL 3: The student achieves independent body and object transport in routine tasks/ activities slowly, with focus and concentration, or in response to modelling/ instruction. He/she engages in practice and/or refining of transport movement sequences/skills. The focus continues to be on the movement rather other aspects of the learning activity
8	Focuses, or attends consciously, to reposition self during routine tasks (e.g., attends consciously to placement of feet; focuses on the movement requirements of the next step of task)	
7	Repeats simple movement sequence in imitation/ memory (e.g., to transfer from chair to floor)	
6	Attempts to avoid obstacles in familiar settings (e.g., gives wide berth; stops to wait for another to pass)	
5	Cooperates (participates as able) in tasks involving transport of routine items	LEVEL 2: The student responds to and actively cooperates/ participates with support in routine learning tasks and activities involving transport of self and objects/ items. He/she undertakes components of transport tasks as able and moves in anticipation of and response to transport components of tasks and activities
4	Cooperates with (assists as able in) the next step of a routine movement (e.g. turns towards; lifts arms)	
3	Reacts when moved around obstacles and through narrow spaces (e.g., holds on; leans in)	
2	Attends to the sensory aspects of objects or environment (such as sight, touch, sound, movement through space, or position in relation to gravity)	LEVEL 1: The student passively experiences and responds to sensory aspects of objects and bodily movement through space. He/she relies on proximity of adult/ support personnel and direct, ongoing assistance to achieve self or object transport goals
1	Shows awareness of being re-positioned or moved (e.g., orients or turns toward direction of travel; reaches to touch surfaces/objects while passing)	

Table 48 *Levels of Dimension 3: Manipulation of Objects and Tools*

Item	Description	Level and Level Statement
16	Writes legibly and fluently while engaged on another task (e.g., writes while simultaneously processing auditory information and cognitively composing)	LEVEL 5: The student achieves successful bilateral coordination and sequencing in multi-step tasks/ activities, and automaticity in object manipulation and use. He/she transfers and generalises manipulation skills to novel tasks; and maintains control of objects when working quickly, or with attention directed elsewhere. He/she successfully achieves the secretarial aspects of writing, while processing the cognitive and language requirements of written tasks.
15	Manipulates and uses tools and materials with appropriate strength and control, while attending to other aspects of task (e.g., moves and stabilises paper while writing; releases object accurately while attending to next step of task)	
14	Adjusts movement response to meet requirements of equipment or activity (e.g., changes movement to keep time with musical rhythms; moves faster to reach ball)	
13	Adapts or adjusts strategies for obtaining objects to suit changing requirements or prevent problems (e.g., alters grip to secure object from falling; holds pen lightly and presses gently when writing)	LEVEL 4: The student refines strategies to calibrate force and timing in relation to handling and using sporting/activity equipment and manipulating and using school tools and materials. He/she engages in repetition and practice to improve handwriting legibility and ease of use. He/she flexibly adapts hand use to changing requirements, and modifies motor responses to achieve best effort
12	Independently adjusts and readjusts movements to correct writing/drawing errors (e.g., repeats attempts using different positions/ grasps to improve neatness/ position of letters on line)	
11	Exploits a range of movement strategies to manage personal school equipment (e.g., uses different body parts to stabilise objects; uses different ways to grip and open lunchbox and food items)	
10	Relies on cues/prompts to direct attention to task requirements and/or verbalize learned strategies in pre-writing tasks (e.g., verbalises direction of movement and strategy for copying/ tracing over shapes)	LEVEL 3: The student sequences simple movements independently; using diverse strategies to manipulate objects. He/she demonstrates increased control of motor patterns and sensory discrimination of objects, and applies conscious attention to strategies or instructions to achieve control of writing implements and success in pre-writing tasks
9	Focuses or slows to use tools and materials with appropriate strength and control (e.g., concentrates to operate joystick on motorised wheelchair; slows to use switch/keyboard/mouse)	
8	Attempts different/alternative strategies for obtaining objects (e.g., one-handed or two-handed methods)	
7	Uses equipment in familiar activities (e.g., passes items to a partner in a routine task)	LEVEL 2: The student achieves components of in-hand manipulation with the support of others, or in partner tasks/activities. He/she completes simple routine tasks involving handling and manipulation of objects; demonstrating a range of grasps, and actively holding and exploring writing implements
6	Achieves a component of equipment handling (e.g., holds backpack for another to close)	
5	Demonstrates a general idea of the movements required for handwriting (e.g., scribbles, makes marks on paper)	
4	Uses familiar strategy/ method for obtaining objects (e.g., same raking or swiping strategy for bringing objects to self)	LEVEL 1: The student responds to objects placed within reach by using his/her hands to explore their sensory properties, or to obtain/ draw them closer for use
3	Responds to sensory properties of tools (e.g. tightens/loosens grip, moves fingers over)	
2	Attends to properties or functions of equipment (e.g., responds upon touching; turns towards/pushes away)	
1	Attends to equipment when placed in hand or nearby (e.g. stills body; holds briefly)	

Table 49 *Levels of Dimension 4: Communicative/ Interactive Skills*

Item	Description	Level and Level Statement
9	Regulates physical tension and response during activities with changing energy demands (e.g., calms for quiet activity following activity with raised energy)	LEVEL 3: The student demonstrates appropriate physical responsiveness to social situations. He/she modulates body posture and body language in response to social cues and modifies physical movement and responses in relation to the needs of others. He/she creatively uses his/her body to communicate subtleties of meaning
8	Extends and adapts repertoire of gestures/ facial expressions to suit different needs or audiences (e.g., catches a person's eye and then directs their gaze; exaggerates or alters gestures or facial expressions to imitate others or to convey more nuanced meanings)	
7	Cooperates with others to share the space (e.g., moves responsively; moves over to share desk space)	
6	Uses a strategy to manage physical tension during activity (e.g., requests a break; calms by linking breathing to a slow, repetitive movement)	LEVEL 2: The student follows rules and/or strategies to physically navigate shared space and manage own needs and responses. He/she is developing the ability to use his/her body to communicate a range of intentions and feelings per standard language conventions
5	Manages own needs in shared space (e.g., follows instructions for avoiding bumping into others; experiments with how much room is needed to pass by another safely)	
4	Uses a consistent repertoire of gestures/ facial expressions to establish meaning	
3	Reacts to stimulation or emotion (e.g., changes level of engagement; changes breathing rate)	LEVEL 1: The student is developing the ability to respond to others and environmental contexts with reflexive, and largely sensory responses. He/she makes movements for communication, relying on familiar others to interpret their meaning
2	Uses gestures/ facial expressions interpretable to familiar others	
1	Reacts or attends when others come close	

Table 50 *Levels of Dimension 5: Performance Sustainment*

Item	Description	Level and Level Statement
14	Completes strenuous movement activities comfortably (e.g., at required speed; while maintaining focus on other aspects of task)	LEVEL 5: The student actively adapts and problem-solves to achieve maximum physical engagement and improvement in performance. He/she seeks ways to take advantage of and exploit the movement opportunities in the environment, and actively devises ways to achieve more physically, while respecting limitations/ physical constraints
13	Adapts movement strategies in response to more challenging settings (e.g., devises a new strategy for carrying objects over greater distances; uses an alternative way to travel across a different surface)	
12	With planning, achieves maximum involvement possible within physical limits (e.g., conserves energy by combining steps; sits where possible)	
11	Creates opportunities to move from classroom activities (e.g., different ways to mobilise around classroom; finds novel movement opportunities within routine tasks)	LEVEL 4: The student initiates and seeks out movement opportunities and trials variations and novel ways to move. He/she perseveres to complete strenuous tasks and challenges self to improve. He/she demonstrates more sustained engagement, or attempts to complete longer or more physically demanding routine tasks
10	Manages a strenuous activity at slowed pace, or with rest periods	
9	Initiates an attempt at new or more difficult aspects of tasks (e.g., exerts self to complete task; attempts task on own)	
8	Refers to and applies rules to regulate involvement and activity choice within safe limits (e.g., checks with adult before engaging in new activity)	LEVEL 3: The student performs modified fitness tasks to appropriate levels of skill and endurance, demonstrating increasing willingness to physically engage, and interest in completing activities to time requirements, or at the same speed or faster than others
7	Engages in occasional strenuous movement during activity (e.g., during stretching exercises; while moving to music)	
6	Attempts greater physical involvement in classroom tasks (e.g., puts hand up to block or reduce helper involvement)	
5	Completes tasks within movement capacity with prompting or support (e.g., takes items from backpack when instructed)	LEVEL 2: The student relies on prompting or support of others to sustain engagement in routine physical tasks and to regulate involvement in relation to physical limitations. He/she extends self physically when working with a partner or with the support of external prompts/motivators, and is learning to achieve tasks involving more exertion of effort
4	Maintains energy output for duration of simple routine tasks (e.g., for packing up; for putting away; to move between activities)	
3	Relies on direct instruction to regulate involvement (e.g., takes a break when directed to do so)	
2	Participates in movement activities that are easily achieved, or provide immediate positive outcome (e.g., moves towards desired object or person)	LEVEL 1: The student moves in response to desired objects or activities in close proximity. He/she shows basic awareness of movement and enjoyment in moving or being moved during motor activity engagement
1	Shows awareness of activities placed nearby (e.g., lifts head; vocalises)	

In summary regarding decision-making in Round 3, panellists were invited to comment about any of the issues discussed in the first two rounds and indicate their agreement using a 4-point Likert scale (Strongly agree; Agree; Disagree; Strongly Disagree), which was then, for purposes of establishing consensus, scored dichotomously as either ‘Agree’ or ‘Disagree’ (see Appendix M for Delphi instructions for Round 3). These included:

- Suggested removal of Item 8 from Category 5,
- Suggestion that cognitive skills in movement remain as currently incorporated into the item proficiency steps, rather than become a separate item,
- Final placement of cut-points, and
- Appropriateness and sufficiency of the level statements.

In addition, Round 3 involved decisions about optimal report formats for different stakeholders.

Round 3 – Standard-Setting Consensus and Reporting Considerations

Standard-setting consensus. Panellists agreed with the removal of Item 8 from the final dimension, and the incorporation of cognition into the items. Cut-point decisions were also accepted by all panellists. Final comments and suggestions about the level statements resulted in some minor revisions, a description of which follows.

Dimension 1.

1. A concern with wording of level statement 2:

Panellist 3: *“Level 2 wording clunky – suggest ‘Given external physical or verbal cues from an adult, the child can maintain balance and postural control at selected times, or during static/ table tasks and activities’.”*

Response: Modified the statement to reflect the suggestion while retaining focus on observable student behaviour –

Original:

The student draws on **and learns responsiveness to individualised cues and contexts** to actively position self and commence activity, and with concentration, can maintain balance and postural control at selected times, or during static/ table tasks and activities

Revised:

The student draws on **external cues (physical or verbal)** to actively position self and commence activity, and with concentration, maintains balance and postural control at selected times, or during static/ table tasks and activities.

2. An additional example to expand range of proficiency step 11:

Panellist: “#11 descriptor about climbing stairs could also include a slightly easier example “*moves safely through crowded classroom.*”

Response: Example added. At this level the student’s balance is proficient enough to be backgrounded, so he/she can tackle more challenging tasks – such as crowds when stair-climbing or moving around the classroom –

Original:

Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)

Revised:

Maintains balance and stability with attention directed elsewhere (e.g., **moves safely through crowded classroom**; climbs stairs safely in a crowd)

3. Adjusting Level 3 statement to distinguish it as relating to familiar environments and 4 to reflect increasing proficiency in unfamiliar environments:

Panellist: “Level 3’s “*In mobilising, he/she is able to maintain balance with attention directed elsewhere*”, is too encompassing – use ‘*in familiar situations*’ as a qualifier perhaps?”

Response: Level 3 concerns ability in familiar settings and Level 4 in unfamiliar... in which case the description of Level 3 should reflect this – adjusted accordingly to – ‘*The student adjusts/ corrects posture and position for optimal task engagement and may responsively correct lost seated balance if knocked. In mobilising **in familiar situations**, he/she maintains balance with attention directed elsewhere.*’”

Dimension 2.

- No changes.

Dimension 3.

1. A suggestion to change provision of support for manipulation in Level 2 statement:

Panellist: *"I don't understand 'in-hand manipulation with support...' This is a solo skill. Verbal prompts and visual demonstrations help, but not physical support."*

Response: "Modified to 'requiring hand function'..." –

Original:

The student achieves components of tasks **involving in-hand manipulation** with the support of others, or in partner tasks/activities...

Revised:

The student achieves components of tasks **requiring hand function** with the-support of others, or in partner tasks/activities...

2. A suggestion for recognising handwriting ability in students whose intellectual abilities make meaningful content more difficult than manual skill:

Panellist: *"Level 4 – 'handwriting legibility' difficult – many students with ID may not have achieved meaningful handwriting, while operating at this physical level – perhaps writing implement use or control in letter formation..."*

Response: Changed to include these more inclusive aspects of handwriting –

Original:

The student refines strategies to calibrate force and timing in relation to handling and using sporting/activity equipment and manipulating and using school tools and materials. He/she engages in repetition and practice to improve **handwriting legibility and ease of use**. He/she flexibly adapts hand use to changing activity requirements, and modifies motor responses to achieve best effort

Revised:

The student refines strategies to calibrate force and rhythm/ timing in relation to handling and using sporting/activity equipment and manipulating and using school tools and materials. He/she engages in repetition and practice to improve **writing implement use and control in drawing or letter formation**. He/she flexibly adapts hand use to changing activity requirements, and modifies motor responses to achieve best effort

3. Changed wording recommendations for handwriting Item 13:

Panellist: “#10 wording challenging, though concept is good”; #12 wording contains jargon, though the concept is good and an improvement on the original”

Response: #10 now changed to ‘Relies on externalised strategies...’ and #12 changed to ‘Alters strategies or positioning ...’ –

Item 13 – first revision:

13.2 Relies on **cues/prompts to direct attention to task requirements and/or verbalize learned movement strategies** in pre-writing tasks (e.g., verbalises direction of movement and strategy for copying/ tracing over shapes)

13.3 **Independently adjusts and readjusts movements** to correct writing/drawing errors (e.g., repeats attempts using different position/grasps to improve neatness or position of letters on line)

Dimension 4.

- No changes.

Dimension 5.

- No changes.

Item 13 – final revision:

13.2 Relies on **externalised strategies** in pre-writing tasks (e.g., verbalises or talks through directionality when copying/tracing over shapes)

13.3 **Alters strategies or positioning** to correct writing/drawing errors (e.g., repeats attempts using different positions/ grasps to improve neatness/ position of letters on line)

Report format considerations. As noted in Chapter Four’s literature review, when there are multiple audiences for assessment results, differing information requirements should be considered alongside instrument development, and consultations should take place with key stakeholders (Brindley, 1998). External users need the opportunity to nominate reporting formats that will work best for them, as aggregated scores and gist level statements prepared for public or government audiences do not provide sufficient detail to support planning (Brindley, 2001). Analytical scoring rubrics, on the other hand, both support assessor judgement, and help to pinpoint the optimal intervention zone (Wiseman, 2012). The Delphi

panellists were therefore asked to recommend target group and purposes for three different reporting formats:

1. A single dimension “rocket” report (Griffin, 1995, p.108) divided into six bands, with a black line indicating the student’s current performance level, and a brief description of the overall skill of that learning stage – provided in Figure 44.

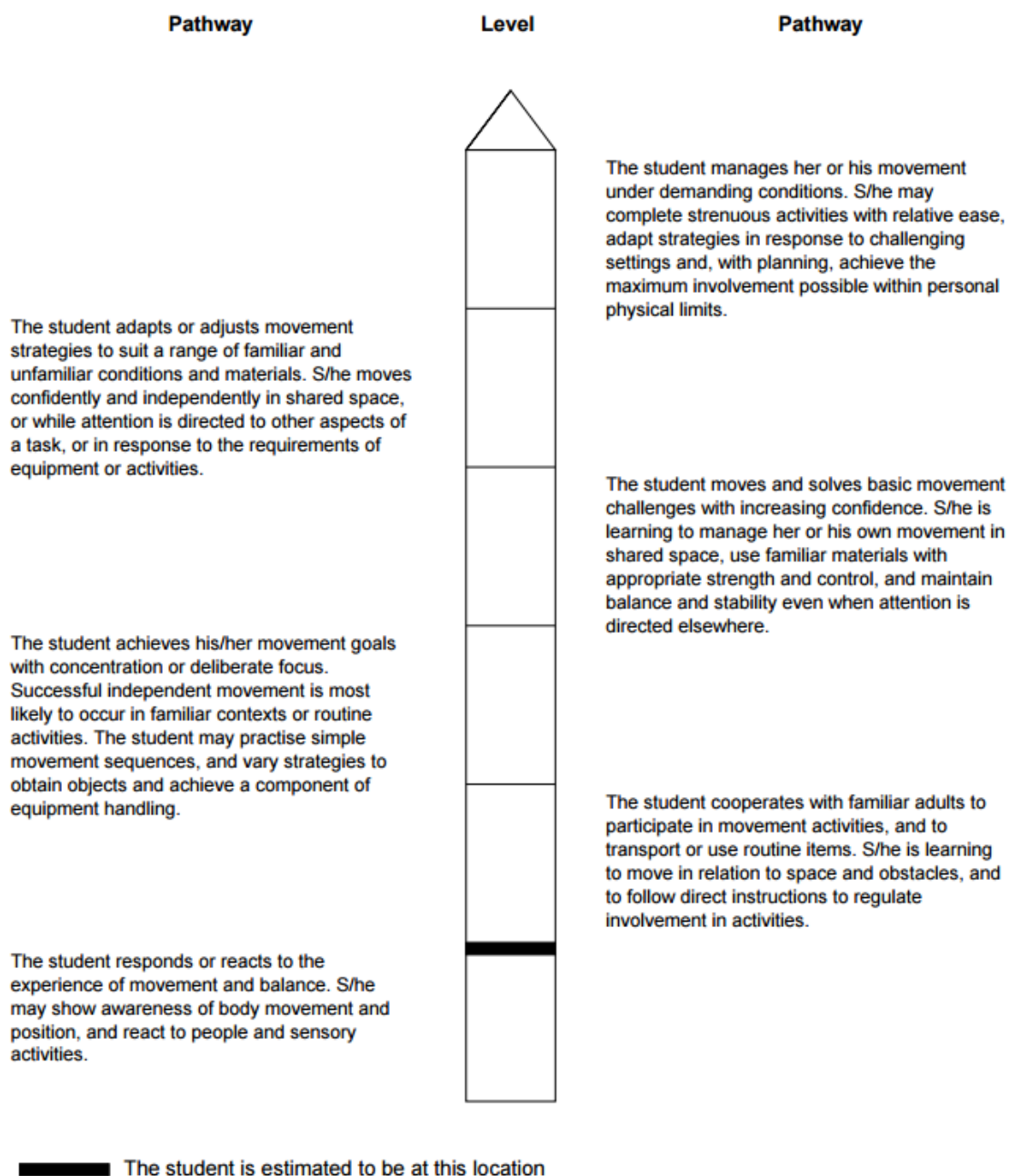


Figure 44. Single-dimension ‘rocket report’ (Griffin, 1995, p.108)

2. A multi-dimensional report, reflecting the results of the Delphi standard-setting work – five dimensions, scaled according to difficulty, each standardised into performance levels, with the circled text indicating the current level of functioning. Figure 45

provides two dimensions as an excerpt, with the full annotated report in Appendix M.

1. Balance, postural control, positioning

LEVEL 4: The student smoothly adjusts and readjusts body position to maintain dynamic balance during movement activities, or in response to changing activity requirements. He/she automatically applies a range of strategies to maintain or regain balance and stability in unpredictable or dynamically changing situations

LEVEL 3: The student adjusts/ corrects posture and position for optimal task engagement, and responsively corrects lost seated balance. In mobilising, he/she maintains balance with attention directed elsewhere

LEVEL 2: The student draws on external cues (physical or verbal) to actively position self and commence activity, and with concentration, is able to maintain balance and postural control at selected times or during static/ table tasks and activities

LEVEL 1: The student attempts to maintain upright head position in seated position and makes reflexive/sensory responses to lost balance. With support to achieve initial posture, he/she engages in learning activities placed before him/her, relying on direct, ongoing support (e.g., supported seating, positioning aids and modifications)

3. Manipulation & use of objects & tools

LEVEL 5: The student achieves automaticity in object manipulation, in written tasks involving linking of motor skills with cognition and language, and bilateral coordination and sequencing in multi-step tasks/activities. He/she transfers and generalises manipulation skills to novel tasks; and achieves fluency and control at speed, and while attending to other aspects of a task

LEVEL 4: The student refines strategies to calibrate force and rhythm/ timing in relation to handling and using sporting/activity equipment and manipulating and using school tools and materials. He/she engages in repetition and practice to improve writing implement use and control in drawing or letter formation. He/she flexibly adapts hand use to changing activity requirements, and modifies motor responses to achieve best effort

LEVEL 3: The student sequences simple movements independently; uses diverse strategies to manipulate objects; demonstrates increased control of motor patterns and sensory discrimination of objects, and applies conscious attention to strategies/ instructions to achieve control of writing tools and success in pre-writing

LEVEL 2: The student achieves components of tasks requiring hand function with the support of others, or in partner tasks/activities. He/she completes simple routine tasks involving handling and manipulation of objects; demonstrating a range of grasps. He/she actively holds and explores the use of writing implements

LEVEL 1: The student responds to objects placed within reach by using his/her hands to explore their sensory properties, or to obtain/ draw them closer for use

Figure 45. Excerpt of multi-dimensional report

3. An itemised report, with items grouped into the five aspects, or dimensions, and the student's score for each item highlighted – provided in Figure 46.

CATEGORY 1 – Balance, postural control and positioning	
1 Maintaining balance and upright posture (seated or standing)	
☐	0 Is moving towards but has not yet achieved this skill
☒	1 Reacts to lost balance (e.g., startles; rights head; extends arms)
☐	2 Relies on strategies or cues to maintain stable posture (e.g., "feet flat, bottom back to sit up straight")
☐	3 Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)
☐	4 Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)
4 Positioning self to engage in activity	
☐	0 Is moving towards but has not yet achieved this skill
☒	1 Responds to activity when positioned in front of it (e.g., shows interest; attempts to reach)
☐	2 Assists in being positioned for activity engagement (e.g., leans/ moves in)
☐	3 Positions self to commence activity (e.g., moves into position to enable use of objects/ tools)
☐	4 Anticipates and adjusts position throughout activity to support efficient functioning

Figure 46. Itemised report grouped into the five dimensions

For this question, the report-format provided was open-response, and more than one selection was permitted as this was not a consensus exercise. Tables 51 and 52 summarise the opinions receiving two or more responses.

Table 51 Target Group for Report Type

Target group	Rocket report (reporting on 1 dimension)	Dimension report (reporting on 5 dimensions)	Itemised report (reporting on 19 items)
Therapists		✓	✓
Teachers/ teaching support staff	✓		✓
Parents	✓		
Doctors, other rehab professionals	✓		
School leadership	✓		

Table 52 *Purpose for Report Type*

Purpose/ use	Rocket report (reporting on 1 dimension)	Dimension report (reporting on 5 dimensions)	Itemised test (reporting on 19 items)
Screening/ summary	✓		
Planning/ goal-setting		✓	✓
Baseline, interim monitoring and outcome measure		✓	✓
Funding/ other planning/ placement recommendations, justifying aide time		✓	✓
Education of aides, new graduates	✓	✓	✓

Therapists were predominantly of the opinion that item-level reporting gave the greatest detail, which resulted in an interesting ‘split’ in perspectives. On the one hand, there was a view that detail is less useful to experienced therapists, and more appropriate for new graduates lacking experience, or others such as teachers and parents from non-therapy backgrounds – for example,

“The itemised report would be good for inexperienced therapists and perhaps students, as having the levels written out makes it easy to see where the child is at, and what is above and below as far as intervention planning and expected progress (goes)”

(Panellist 2, 28 years’ experience)

“The (dimension level) report is best for therapists – the layout is clear, succinct and gives direction for therapy”;

(Panellist 4, 12 years’ experience)

“The best reporting format for therapists is the dimension level - although at first glance the itemised report seemed likely - in fact the additional detail in this format is not helpful to an OT referral. As an OT I would tend to want to make my own further assessments to understand movement and would not use the additional information if it was provided.”

(Panellist 5, 30 years' experience)

On the other hand, there was a view that greater detail is appropriate for therapists because of their specialist expertise – for example,

“The itemised report gives the detail required for direct intervention by OT.”

(Panellist 1, 20 years' experience)

One therapist preferred the item-level report because it also contained the categories, though did not note the loss of the level statements in this format,

“I think the itemised report with categories would be useful for therapists, as this would guide goal-setting for the individual child.”

(Panellist 3, 25 years' experience)

Finally, the panel predominantly considered that teachers would benefit most from the itemised report, though two panellists also felt the gist-level would give sufficient information. Again, this reflected the understanding of the usefulness of report detail to level of expertise – as teachers lacked training in motor skill acquisition, they were deemed as either needing, or not needing, a detailed report.

The report considered by most panellists as sufficient for parents and school leadership was the single dimension rocket report.

Chapter Summary

This chapter has reported on the work of a group of paediatric occupational therapy experts brought together in a Delphi panel to set standards and consider reporting formats for the goal-directed movement learning progression developed in Study 1. Five sub-dimensions were confirmed through this process – balance and positioning; transportation of self and objects; manipulation and use of objects and tools; self-management, self-expression and social interaction; and fitness, endurance and motivation, and panellists also reached consensus agreement with the results of the multidimensional IRT modelling of Chapter Seven that had placed the 19 items in these dimensions.

Four levels of progression for balance, postural control, and positioning were identified, beginning with largely reflexive and sensory responses to loss of balance reliant on full support to achieve stability and maintain this without tiring, to abilities in familiar, static tasks by reliance on cues and strategies, to growing capacity to correct lost posture and maintain stability with attention directed elsewhere, to finally, advanced skills in smoothly adjusting and readjusting position and maintaining balance in dynamic and novel situations.

Five levels of ability in transporting self and objects were identified, beginning with passive experiences of being moved by others, to greater coactive involvement in moving and undertaking components of transport tasks, to independent transport of self and objects provided this was undertaken slowly with focus on the movement aspect alone, to an increased ability to problem-solve in more complex transport tasks, and finally, to skilled execution of multi-aspect tasks involving transport of self and objects with focus elsewhere.

Five levels of manipulation ability were also identified, with students developing increasing sophistication in grasping and using classroom-related tools with appropriate force, rhythm and timing through repetition and practice, until finally, at the top level, they could link motor skills with other classroom requirements with fluency and requisite speed.

Three levels of skill in managing communication and interaction with others were identified, from a beginning reliance on others to interpret meaning and facilitate engagement, to learning and adhering to rules and strategies to manage shared space and use the body to communicate according to standard conventions, and finally, to achievement of modulated body posture and body language in response to social cues, and skilled and creative use of the body to communicate subtleties of meaning.

Finally, five levels of performance sustainment were identified, from early experiences of enjoying movement, to more active movement in response to prompting and external motivators, to a greater willingness to engage during modified fitness tasks and persevere in more demanding activities within personal limits, to regular engagement in strenuous movement and commitments to maintaining and extending physical involvement.

In relation to reporting formats for different end-users, the Delphi panel considered the itemised test report format most appropriate for teachers, as its greater detail would support their lack of expertise, and the gist level ‘rocket report’ more appropriate for parents and school leadership who would require an achievement summary only. For their own needs, three of the five therapists considered the dimension report most appropriate to their clinical expertise, however, the reasons given by the other two therapists for selecting the itemised test report suggested an ongoing commitment to a ‘checklist’ intervention approach, consistent with the perspectives of the profession that had been noted in Chapter Four’s review of the assessment research literature (Richardson, 2015).

The original design framework in Chapter Three’s literature review on the construct had hypothesized a six-level structure for the items as an integral part of instrument development. It was now possible to compare this original design with the empirically derived standards produced by the Delphi panel’s standard-setting efforts, and the results of the MIRM analysis. This comparison is shown in Table 53.

Table 53 *Comparison between Hypothesized and Derived Standards for Movement*

Hypothesized Standard	Derived Standard				
	1. Balance, posture, positioning	2. Transportation of self & objects	3. Manipulation & use of objects & tools	4. Communicative/ interactive skills	5. Performance sustainment
Holistic appraisal of situations and movement requirements; resourceful use of body and environment to maximise goal achievement in novel tasks; automaticity and efficiency in routine movements, permitting multi-tasking		LEVEL 5: The student transports self and/or objects effortlessly and fluently within diverse and dynamically changing environments; he/she achieves multiple additional activity goals concurrently, requiring cognitive attention and dynamic adjustment to unfolding/ unpredictable situations	LEVEL 5: The student achieves automaticity in object manipulation; in written tasks involving linking of motor skills with cognition and language; and bilateral coordination and sequencing in multi-step tasks/activities. He/she transfers and generalises manipulation skills to novel tasks; and achieves fluency and control at speed, and while attending to other aspects of a task		LEVEL 5: The student actively adapts and problem-solves to achieve maximum physical engagement and performance improvement. He/she seeks ways to take advantage of movement opportunities in the environment, and actively devises ways to achieve more physically, while respecting limitations
Knows many movement routines; benefits from past problem-solving experiences; manages movement in many different environments	LEVEL 4: The student smoothly adjusts and readjusts body position to maintain dynamic balance during movement activities, or in response to changing activity requirements. He/she automatically applies a range of strategies to maintain or regain balance and stability in unpredictable or dynamically changing situations	LEVEL 4: The student applies problem-solving skills in response to unexpected task/activity requirements, to continue to safely achieve transport goals. He/she successfully transports objects in more complex, or non-routine tasks. Repetition and practice results in increasingly successful outcomes in terms of efficiency and speed	LEVEL 4: The student refines strategies to calibrate force and rhythm/ timing in relation to handling and using sporting/activity equipment and manipulating and using school tools and materials. He/she engages in repetition and practice to improve writing implement use and control in drawing or letter formation. He/she flexibly adapts hand use to changing activity requirements, and modifies motor responses to achieve best effort	LEVEL 3: The student demonstrates appropriate physical responsiveness to social situations. He/she modulates body posture and body language in response to social cues and modifies physical movement and responses in relation to the needs of others. He/she creatively uses his/her body to communicate subtleties of meaning	LEVEL 4: The student initiates and seeks out movement opportunities and trials variations and novel ways to move. He/she perseveres to complete strenuous tasks, and challenges self to improve. He/she demonstrates more sustained engagement, or attempts to complete longer or more physically demanding routine tasks
Meets additional requirements by reducing redundant good variance; modifies routine movements to account for variations; selectively attends to relevant input; explores, practises	LEVEL 3: The student adjusts/ corrects posture and position for optimal task engagement, and responsively corrects lost seated balance if knocked. In mobilising, he/she maintains balance with attention directed elsewhere	LEVEL 3: The student achieves independent transport of self/objects in routine tasks slowly, with concentration, or in response to modelling/ instruction. He/she engages in practice and/or refining of transport sequences/skills. The focus continues to be on the movement, rather other aspects of the learning activity	LEVEL 3: The student sequences simple movements independently; uses diverse strategies to manipulate objects; demonstrates increased control of motor patterns and sensory discrimination of objects, and consciously attends to strategies or instructions to achieve control of writing implements and success in pre-writing	LEVEL 2: The student follows rules and/or strategies to physically navigate shared space and manage own needs and responses. He/she is developing the ability to use his/her body to communicate according to standard language conventions	LEVEL 3: The student performs modified fitness tasks to appropriate levels of skill and endurance, demonstrating increasing willingness to physically engage, and interest in completing activities to time requirements, or at the same speed or faster than others
Achieves movement slowly, when singly focused and concentrating; uses external cues/ prompts; automaticity in basic routines	LEVEL 2: The student draws on external cues (physical/verbal) to position self and commence activity and, with concentration, maintains balance and postural control at selected times or during static/ table tasks and activities		LEVEL 2: The student achieves components of tasks requiring hand function with the support of others, or in partner tasks/activities. He/she completes simple routine tasks involving handling and manipulation of objects; demonstrating a range of grasps. He/she actively holds and explores the use of writing implements		LEVEL 2: The student relies on prompting or support to sustain engagement in routine tasks and regulate involvement re limitations. He/she extends self physically when working with partner or with support of external prompts, and is learning to achieve tasks involving more exertion
Achieves components of movement with support; follows simple, context-free rules; actively explores movement with support; imitates others	LEVEL 1: The student attempts to maintain upright head position in seated position, makes reflexive/sensory responses to lost balance. With support to achieve initial posture, engages in learning activities placed in front, relying on direct, ongoing support (e.g., supported seating position aids))	LEVEL 2: The student responds to, and actively cooperates/ participates with support in routine learning tasks and activities involving transport of self and objects/ items. He/she undertakes components of transport tasks as able, and moves in anticipation of and response to transport components of tasks and activities	LEVEL 1: The student responds to objects placed within reach by using his/her hands to explore their sensory properties, or to obtain/ draw them closer for use	LEVEL 1: The student is developing the ability to respond to others and environmental contexts, with reflexive, and largely sensory movement responses. He/she makes movements for communication, relying on familiar others to interpret their meaning	LEVEL 1: The student moves in response to desired objects or activities close by. He/she demonstrates basic awareness and enjoyment of moving during activity
Awareness and observation of others; reactive responses to sensory stimuli		LEVEL 1: The student passively experiences and responds to sensory aspects of objects/ movement. He/she relies on adult support, and direct assistance to achieve transport goals			

As well as congruence at the standards level, a close alignment between hypothesized and empirical difficulty ordering of item proficiency steps was achieved. Two examples are,

- The top item-steps of Items 1, 2, 4, 6, and 7 were confirmed as relatively easier skills that did not require the degree of proficiency called on by Items 13 and 17-19, and
- The mid-point item-steps of all items other than 2 and 18 (original 15) had their middle-level positions confirmed. The derived placements of Item 2.2 (Uses a strategy to manage physical tension) and 18.2 (Adheres to rules regarding level of involvement) were significantly harder than hypothesized.

Taken together with the excellent item and person-separation reliability indices (0.98 and 0.97 respectively), the results reported in these chapters support construct validity for the scale and confidence that students placed along it could be interpreted as operating at a level of ability and readiness to learn commensurate with their emerging capacity in the construct, thus providing an abilities-based starting point for intervention decisions (Wright & Stone, 1979).

A final question was the degree to which impairment severity impacted scale performance, as the literature had suggested a link between the former and sufficiency of opportunity to practice – understood to be the determinant of skill achievement (Gordon & Magill, 2012). The scale was designed to be inclusive of all physical abilities and to enable goal-directed movement capability to be demonstrated regardless of level or type of impairment. At the same time, without sufficient opportunity to practice – a situation likely with severe impairment, performance outcomes would be reduced. It was expected this situation would result in a greater proportion of students with profound and severe levels of disability being found at the lower levels of the scale. Examining this is the subject of Chapter Nine.

Chapter Nine: Bivariate Results of Factors Influencing Performance

This chapter reports on the results of cross-tabulation and chi-square analyses of the trial data to investigate the influence of student impairment characteristics on scale performance, in response to the final research question which asked the influence of background characteristics on goal-directed movement development. As stated in the methodology Chapter Five, crosstabulation arranges data from two categorical variables so one variable constitutes the rows and the other the columns of a table. A chi-square test of independence is then conducted to establish whether the null hypothesis of absence of relationship stands. If results do not support this conclusion, the alternative hypothesis of an association between the variables is suggested, though inferences about causation cannot be made.

In relation to this study, firstly, Chapter Two's literature review had suggested an inverse relationship between physical impairment and provision of movement practice opportunity, increasing with impairment severity (OTA, 2012; Ott & Effgen, 2000), while the demographic questionnaire of the main study had enabled a categorisation of impairment severity into four levels. Secondly, Chapter Three's review of motor skill acquisition research had noted the importance of intensive, task-oriented training in natural tasks and settings to secure and further motor skill (Adolph & Berger, 2006; Armstrong, 2012; Effgen & Chan, 2010; Gordon & Magill, 2012; Hollenbeck & Miller, 2013; McDonald et al., 2001; Phipps & Roberts, 2017). Also noted was the situation in general classrooms where non-curricular motor requirements of learning were typically perceived as barriers to academic learning and reduced or removed (Effgen & Chan; Evans, 2013; Forsyth & Basu, 2014; Oliver, 1989), with concurrence from the physical rehabilitation literature, that potential movement practice opportunities were being removed from students most in need of them (Asbornslett & Hemmingsson, 2008; Cameron, Murrah, et al., 2012b; Colangelo & Olson, 2013; Egilson & Traustadottir, 2009a, 2009b; Missiuna & Pollock, 1991). Arising from this,

a goal of this final study was to understand the impact of reduced movement opportunities on task-related motor performance as defined by this scale – in other words, to what extent was there a relationship between these two variables?

Secondly, the literature review had suggested extensive requirements for intact upper body functioning to fulfil fine-motor classroom requirements (Hoy et al., 2011; McHale & Cermak, 1992; McMaster & Roberts, 2016). This led to a query regarding the impact of impaired upper-body functioning on Dimension 3 performance, which concerned skills for handwriting and manipulating and using classroom learning tools. Therefore, a second chi-square analysis was conducted to establish the presence or otherwise of this association.

To test both associations, as explained in methodology Chapter Five, these background features from the trial's expanded demographics questionnaire were cross-tabulated with the student ability estimates from the multidimensional IRT analysis of trial results that had been recoded into band levels by the Delphi expert panel. This standard-setting work then enabled allocation of score ranges to each level of each dimension – recoding the weighted likelihood estimate of ability (WLE) equivalence scores for each of the dimensions into the levels by attending to the threshold scores for the item proficiency steps above and below each cut-point the panellists had set. Table 54 summarises the score ranges for each of these levels, laid out in ascending order by difficulty. This then permitted an examination of the influence of these background characteristics on performance.

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Table 54 *WLE Score Range for Levels of the Five Dimensions*

Recoded variable:	Score ranges between cut-points:				
	Dim. 1	Dim. 2	Dim.3	Dim. 4	Dim. 5
Level 5	-	≥ 2.85	≥ 3	-	≥ 3.7
Level 4	≥ 1.8	≥ 0.4 , < 2.85	≥ 1.5 , < 3	-	≥ 2.1 , < 3.7
Level 3	≥ 0 , < 1.8	≥ -1.5 , < 0.4	≥ 0 , < 1.5	≥ 1.8	≥ 0 , < 2.1
Level 2	≥ -2 , < 0	≥ -3.5 , < -1.5	≥ -3 , < 0	≥ -1.7 , < 1.8	≥ -2.9 , < 0
Level 1	< -2	< -3.5	< -3	< -1.7	< -2.9

Specifically, the demographics questionnaire had asked two questions:

1. Each student's impairment severity, through nomination of one of four levels of required support provision (extensive help or supervision; aids, cues, or prompts; independent though difficulty completing extended tasks; no assistance required). Importantly, this need for support did not imply physical difficulties were the cause, nor were physical difficulties necessarily implicated in support provision.
2. Bodily impact/location of the impairment, again providing four options but allowing multiple selection (difficulty with arms and fingers; difficulty gripping; difficulty with legs or feet; a condition restricting physical engagement). A cross-tabulation of two of these results was made – between students selected as having difficulties using their arms and fingers or gripping things (upper body difficulties), and students with difficulties using their legs and feet (lower body difficulties).

Results of these analyses are set out in Figures 47 to 51 and Tables 55 to 59, looking firstly at impairment severity and secondly at bodily location/functional difficulty. In these depictions, for each dimension, band levels determined through the standard-setting process

are presented on the y-axis/ rows in ascending order by difficulty, and performance of the student sample by impairment on each severity variable, or by bodily location, is presented as percentage bars/ columns on the x-axis.

Relationship of Impairment Severity to Scale Performance

Dimension 1: Balance, postural control, and positioning

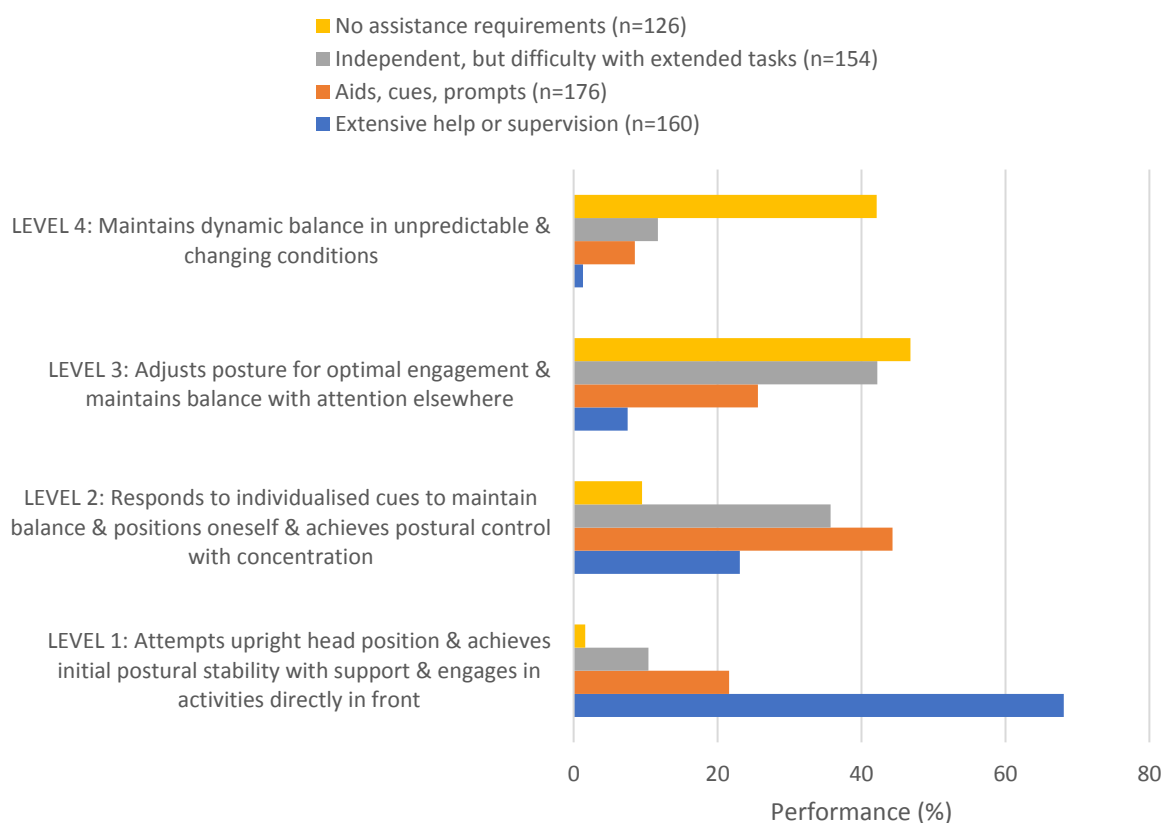


Figure 47. Dimension 1: Balance, postural control, and positioning

Figure 47 shows that, in relation to the skills of Dimension 1, students with no assistance requirements predominantly achieved the highest two levels of the scale, while students requiring extensive physical support performed predominantly at the lowest skill level. In between these highest and lowest levels, students with needs for aids, cues and prompts predominantly achieved Level 2 and students who were independent in routine, non-extended motor tasks were more likely to be placed at proficiency Level 3. Looking at outliers, two students with extensive support needs achieved the top score of 8 – these children (both boys;

8 and 10 years of age) had intellectual impairments but no physical functioning difficulties; and at the other extreme, one student without support needs could not be placed on the scale (receiving a score of 0) – this was a 6-year-old boy with intellectual impairment and also no physical functioning difficulties. In other words, at the extreme ends, the presence of physical functioning difficulty made top performance difficult but did not contribute to lowest performance. Therefore, the skill range of Dimension 1 was sufficiently comprehensive at the lower end for students with physical functioning difficulties to be placed on the scale, and sufficiently difficult at the higher end for top performers to still have an aspirational goal. This situation was similar across all Dimensions of the scale.

The indication of a relationship between the variables was supported by a Pearson Chi-square test for independence, which showed a statistically significant relationship between performance level and impairment severity – $\chi^2 (12; n=650) = 343.109; p<0.001$. Table 55 sets out the expected (Exp.), observed (Obs.) and adjusted residuals (AdjR.) for each of the degrees of impairment severity, highlighting those categories of students who most influenced the statistically significant Chi-square score. Students of all impairment severities were able to perform across the levels of the scale; however, this spread was less likely for students both with profound impairments and mild or no impairments.

Table 55 *Results by Impairment Severity: Dimension 1 (Balance, Posture, Positioning)*

Level:	Impairment severity:											
	No assistance required			Independent but difficulty			Aids, cues, prompts			Extensive help required		
	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.
4	19.6	53	9.2	23.9	18	-1.5*	27.3	15	-3.0*	24.9	2	-5.7*
3	37.8	59	4.6	46.2	65	3.8	52.8	45	-1.5*	48	12	-7.2*
2	36.1	12	-5.3*	44.1	55	2.2	50.4	78	5.4	45.8	37	-1.8*
1	32.6	2	-6.9*	39.8	16	-5.0*	45.5	38	-1.5*	41.4	109	14.1

*Note: Negative scores indicate an inverse relationship between variables.

As stated in Chapter Five, adjusted residuals greater than 2 or less than -2 suggest the null hypothesis should be rejected for those cases/cells. On this calculation, Table 55 shows that

the likelihood of students with no assistance requirements achieving the higher Levels 3 and 4 and not the lower Levels 1 and 2 was very high (indicated by all the adjusted residual scores of that category), and the likelihood of students with extensive support requirements achieving the lowest Level 1 and not the higher Levels 3 and 4 was also very high (indicated by the adjusted residual scores of 14.1, 7.2, -5.7). Somewhat weaker relationships existed between impairment severity and level performance for students in the middle two categories, where the adjusted residuals were closer to the mean. These findings supported assumptions that impairment severity impacts performance and bore out the usefulness of the cut-points and standards devised by the Delphi panel to identify substantive ability differences between students. Figure 48 shows these results for Dimension 2.

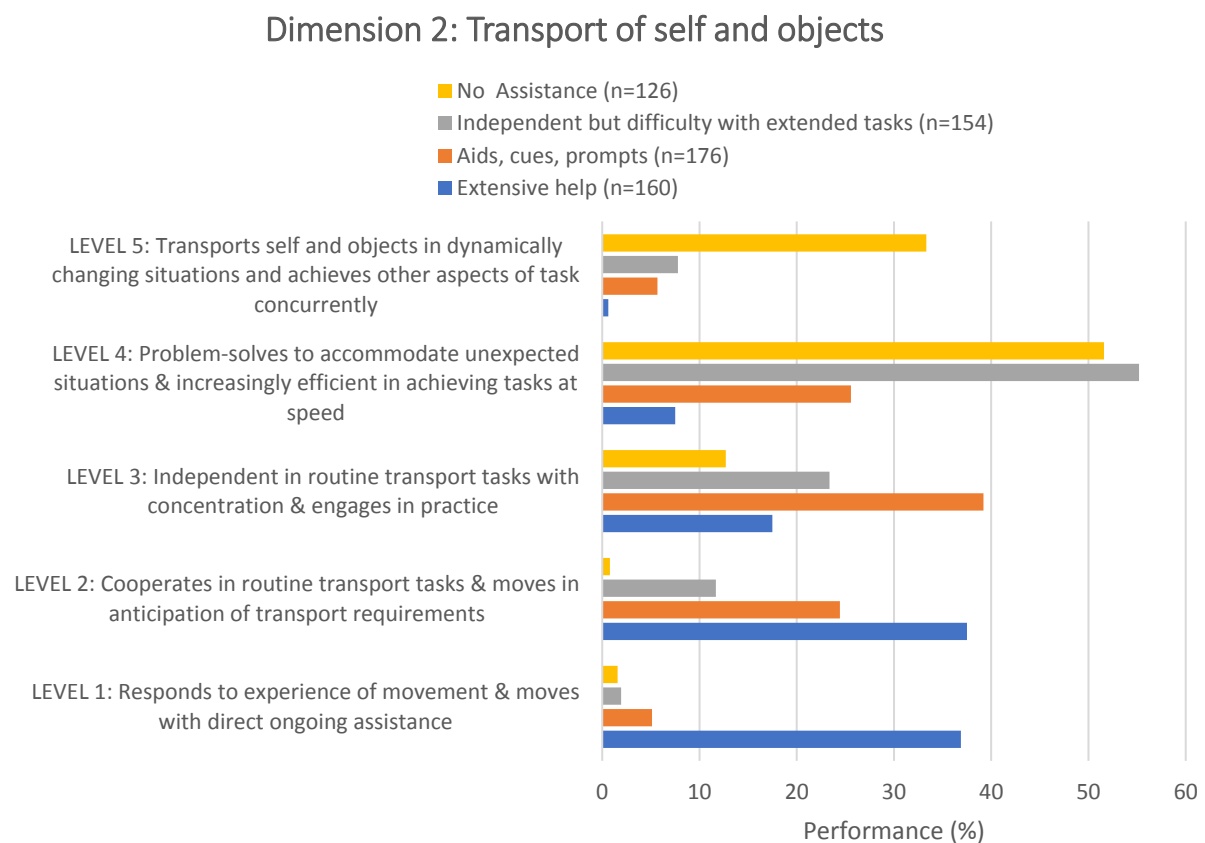


Figure 48. Dimension 2: Transport of self and objects

Figure 48 depicts similar findings for Dimension 2 as for Dimension 1 – most students with extensive support needs achieved the lower levels of the scale, and students with no

assistance requirements achieved the higher levels, while between these two groups, students with needs for aids, cues and prompts performed mainly at Level 3, and most students who were largely independent in routine, non-extended tasks achieved Level 4 (over 55%). The markedly lower likelihood of the latter group in achieving the final level (less than 8%) aligned to the nature of their difficulties achieving extended tasks, as the top skills of this dimension required the ability to move in situations of instability or concurrent execution of other tasks – by nature extended abilities (Gentile, 2000). Concluding similarly to Dimension 1, physical difficulty did not permit a top score in Dimension 2, but was not a factor in failure to score, implying that for this Dimension also, the skill range was sufficiently comprehensive to place students with significant physical functioning difficulties on the scale, but sufficiently difficult at the upper end to provide goals to work towards for the most able group.

The appearance of a relationship between these variables was again supported by the Chi-square analysis, which showed a statistically significant relationship between performance level attained and impairment severity – $\chi^2 (16; n=650) = 369.522; p<0.001$. Table 56 sets out the expected (Exp.), observed (Obs.) and adjusted standardised residuals (Resid.) for each of the degrees of impairment severity, highlighting those categories of students most influential on the statistically significant Chi-square score. Again, students of all impairment severities were able to perform across the scale; however, this spread was significantly reduced for students with extensive and no support needs, who were clustered at the extremes.

Table 56 *Results by Impairment Severity: Dimension 2 (Transport of Self and Objects)*

Level:	Impairment severity:											
	No assistance required			Independent but difficulty			Aids, cues, prompts			Extensive help required		
	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.
5	14.5	42	8.5	17.8	12	-1.7	20.3	10	-2.8	18.5	1	-5.0
4	43.2	65	4.6	52.8	85	6.3	60.4	45	-2.9	54.9	12	-8.2
3	30.2	16	-3.3	37	36	-0.2	42.2	69	5.5	38.4	28	-2.2
2	23.8	1	-5.8	29.1	18	-2.6	33.3	43	2.2	30.3	60	9.2
1	14.2	2	-3.8	17.3	3	-4.2	19.8	9	-3.0	18	59	11.8

In comparing observed frequencies with those expected in a condition of no relationship, Table 56 demonstrates large differences between observed and expected performance for students with no assistance requirements working at the highest Levels 4 and 5 (indicated by the adjusted residual scores of 4.6 and 8.5), students with extensive support requirements working at the lowest Levels 1 and 2 and not at the highest Level 5 (indicated by adjusted residual scores of 11.8, 9.2, and -8.2), and students with no assistance requirements working at Levels 4 and 5 (indicated by adjusted residual scores of 4.6 and 8.5). Somewhat less difference was seen between support needs and level performance in the case of students from the middle two categories, though the predominant placement of students requiring aids, cues, and prompts into Level 3 (adjusted residual score of 5.5) and the placement of students with a basic level of independence into Level 4 (adjusted residual score of 6.3) showed a significant association. Overall, these findings aligned with assumptions that severity of impairment impacted performance, as well as supporting the cut-points and standards of the Delphi panel, and the goal of the criterion-referenced scale to be achievable across its range to students with all degrees of support need. Dimension 3 evidenced a similar outcome, as Figure 49 shows.

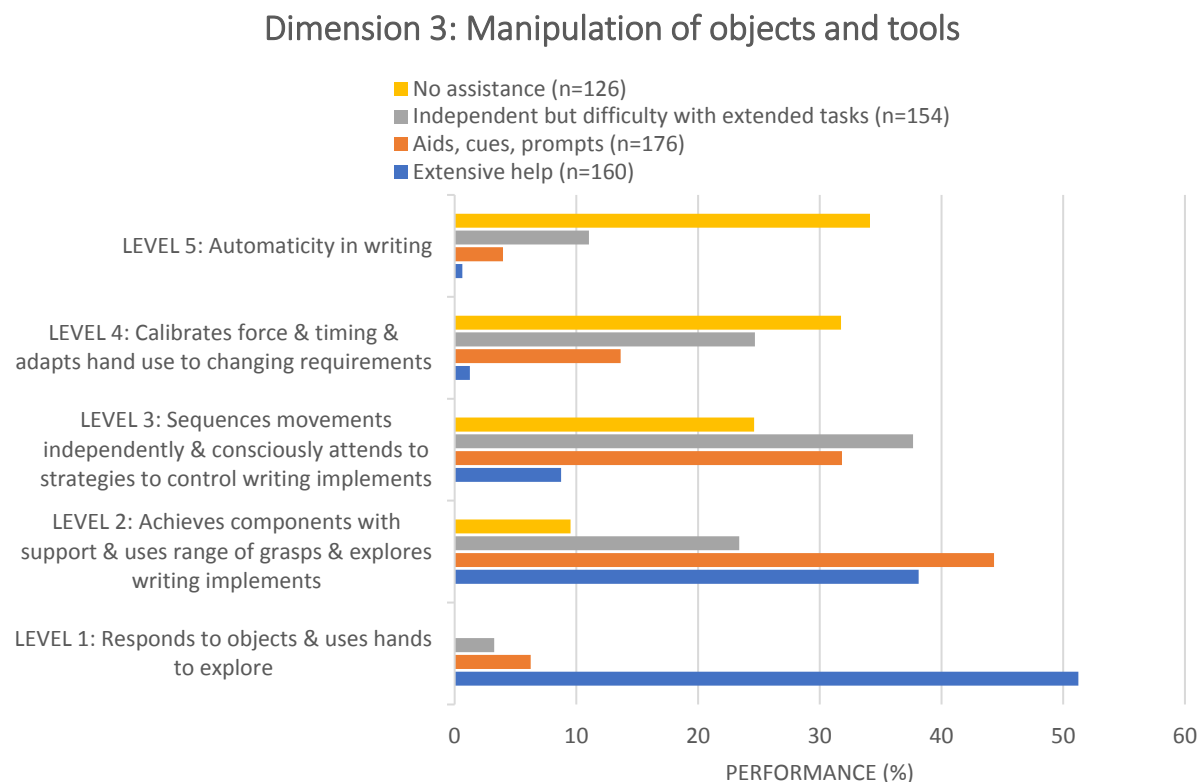


Figure 49. Dimension 3: Manipulation of objects and tools

While students with no assistance requirements more easily achieved the final level of Dimension 3, Figure 49 indicates that students with needs for aids, cues, and prompts, as well as those who were independent with difficulty found these skills more challenging to demonstrate – the former group predominantly scoring in the exploratory Level 2, and the latter group scoring mainly at Level 3, involving the need for concentration upon the movement task to achieve it. At the same time, the alignment of students by impairment severity to performance on the standards of the scale continued to support the assumptions of this research.

The appearance of a relationship between these variables was again supported by the Chi-square analysis, which showed a statistically significant relationship between performance level attained and impairment severity – $\chi^2 (16; n=650) = 387.156; p < 0.001$. Tale 57 provides the scores for each of the degrees of impairment severity, highlighting those categories of students most influencing the statistically significant Chi-square score.

Table 57 *Results by Impairment Severity: Dimension 3 (Manipulation of Objects and Tools)*

Level:	Impairment severity:											
	No assistance required			Independent but difficulty			Aids, cues, prompts			Extensive help required		
	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.
5	14.7	43	8.7	18.0	17	-0.3	20.6	7	-3.7	18.7	1	-5.0
4	21.9	40	4.7	26.8	38	2.7	30.6	24	-1.5	27.8	2	-6.2
3	33.3	31	-0.5	40.8	58	3.6	46.6	56	1.9	42.3	14	-5.8
2	37.0	12	-5.5	45.3	36	-1.9	51.7	78	5.1	47.0	61	2.8
1	19.0	0	-5.3	23.2	5	-4.7	26.5	11	-3.8	24.1	82	14.7

Table 57 demonstrates large differences between observed and expected performance for students with no assistance requirements achieving the highest Levels 4 and 5 (indicated by the adjusted residual scores of 8.7, 4.7, -5.5 and -5.3), and students with extensive support requirements being assessed at the lowest level (indicated by the adjusted residual scores of 14.7, -5.8, -6.2, and -5). Students with no assistance needs were not placed in the lowest level of this Dimension. Smaller differences occurred between impairment severity and performance for students from the middle two support need categories, while greater association existed between students requiring aids, cues, and prompts and placement into Level 2 (indicated by the adjusted residual score of 5.1), but not into Levels 1 or 5 (indicated by the adjusted residual scores of -3.8 and -3.7 respectively), and between students of largely independent ability being placed into Level 3, but not into Level 1 (indicated by the adjusted residual scores of 3.6 and -4.7). Consideration of this in relation to Dimension 4 is depicted next, in Figure 50.

Dimension 4: Communicative/ interactive skills

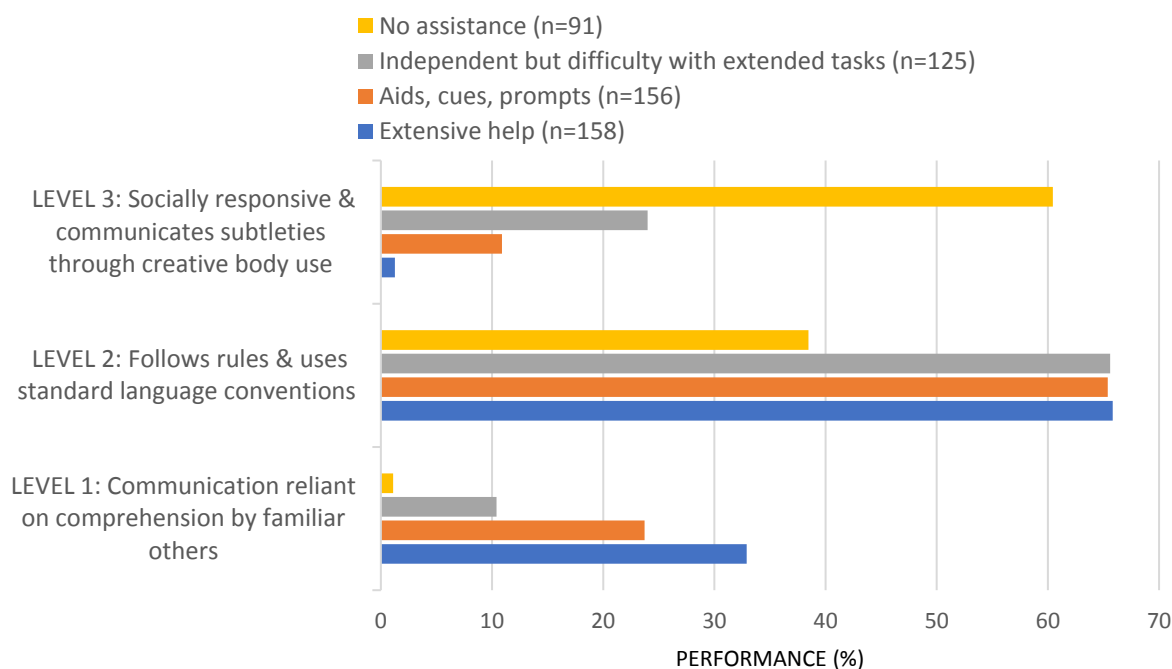


Figure 50. Dimension 4: Communicative/ interactive skills

Students other than those requiring no assistance were predominantly located in the second level of Dimension 4, where gestural communication by standard convention and beginning abilities with managing one's own needs featured. Level 1 skills required communication partners who knew the student, as at beginning stages of communication, non-conventional gestures and movements predominated. The threshold breaks between levels were reasonably large for this dimension (almost 3 logits between Levels 1 and 2, and over 1 logit between Levels 2 and 3), and there was a marked fall off between the last two levels – implying that the skills of communicating subtleties of meaning with the body and regulating bodily tension, were difficult to acquire or demonstrate for this group of students. While two children with extensive support requirements were able to achieve the top level of this Dimension (the 10-year-old boy with intellectual disability and ADHD, and a 7-year-old girl with physical, intellectual, vision, and speech/language impairments and upper body functioning difficulties), neither achieved the top score, and the student with no assistance

requirements who scored at the lowest level – an 18-year-old male with ASD and intellectual disability, yet achieved a score of 2. In other words, all students were able to be located within Dimension 4's ability range.

Once again, Chi-square analysis showed a statistically significant relationship between performance level attained and impairment severity – $\chi^2 (8; n=556) = 162.241; p < 0.001$. Table 58 provides the scores for each of the degrees of impairment severity, highlighting those categories of students most influencing the statistically significant Chi-square score.

Table 58 *Results by Impairment Severity: Dimension 4 (Communicative/ Interactive Skills)*

Level:	Impairment severity:											
	No assistance required			Independent but difficulty			Aids, cues, prompts			Extensive help required		
	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.
3	18.7	55	10.3	25.6	30	1.1	32.0	17	-3.5	32.4	2	-7.1
2	55.3	35	-4.8	76.0	82	1.3	94.8	102	1.4	96.1	104	1.5
1	17.0	1	-4.7	23.4	13	-2.7	29.2	37	1.9	29.6	52	5.4

Large differences between observed and expected results were again seen between variables of this Dimension for students with extensive support needs, who were placed at the lowest and not at the highest levels (indicated by the adjusted residual scores of 5.4 and -7.1), and all the scores of students with no assistance requirements showed statistical significance (adjusted residual scores of -4.7, -4.8, and 10.3). Again, a significantly lower strength of relationship between support need and level performance was evident in students from the middle two categories, whose results were spread more evenly. Consideration of this in relation to Dimension 5 is depicted next, by Figure 51.

Dimension 5: Performance sustainment

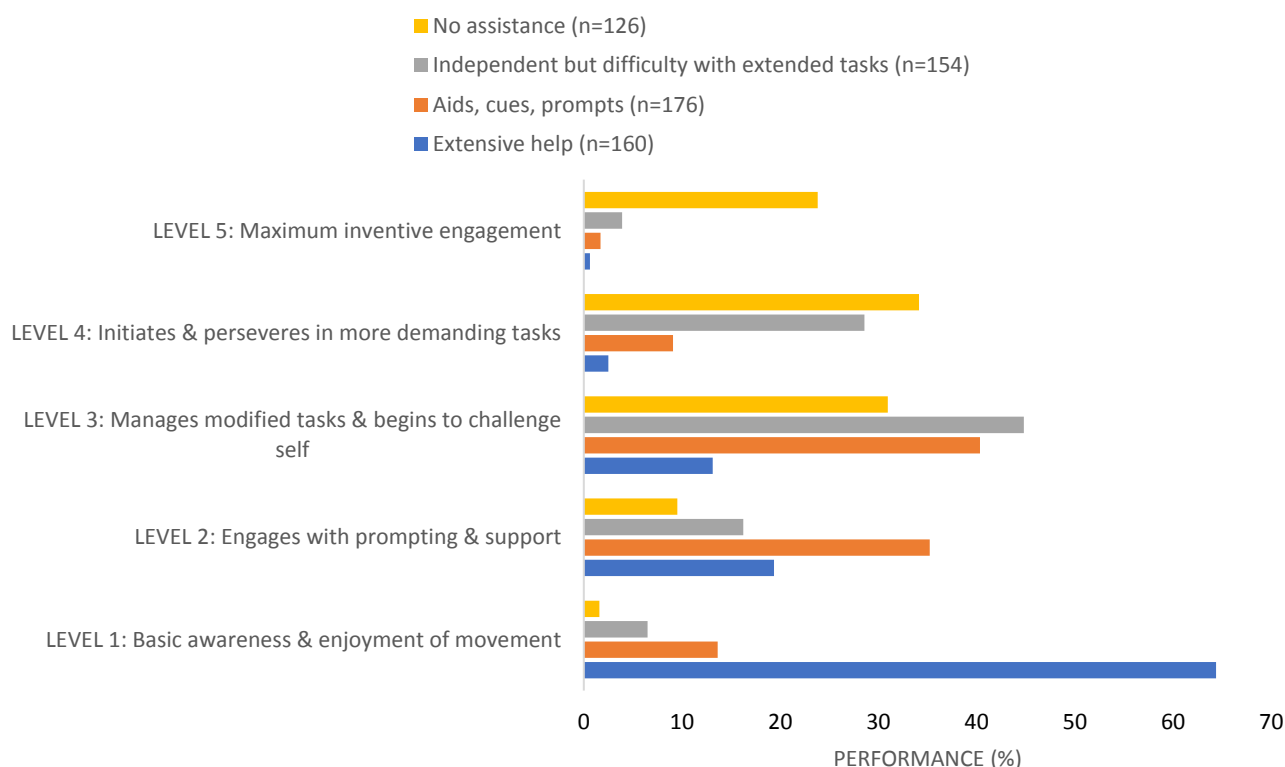


Figure 51. Dimension 5: Performance sustainment

The skills of Dimension 5 were among the hardest of the scale, which Figure 51 demonstrates in that students not needing assistance were more prevalent in the fourth than the fifth level and almost 65% of students with extensive support needs achieved only first level skills. Students in the middle two categories performed across the scale, but with a marked drop-off at the final level where a high degree of capacity in relation to motivation, perseverance, and fitness was required. Once again, the range of skills for this Dimension were sufficiently comprehensive to describe the lowest ability level while continuing to provide aspirational targets for students of highest ability.

Chi-square analysis again showed a statistically significant relationship between performance level attained and impairment severity – $\chi^2 (16; n=650) = 381.607; p < 0.001$.

Table 59 provides the scores for each of the degrees of impairment severity, highlighting those categories of students most influencing the statistically significant Chi-square score.

Table 59 *Results by Impairment Severity: Dimension 5 (Performance Sustainment)*

Level:	Impairment severity:											
	No assistance required			Independent but difficulty			Aids, cues, prompts			Extensive help required		
	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.	Exp.	Obs.	AdjR.
5	8.3	30	8.6	10.2	6	-1.6	11.6	3	-3.1	10.6	1	-3.5
4	23.3	43	5.0	28.4	44	3.7	32.5	16	-3.8	29.5	4	-6.0
3	40.9	39	-0.4	50	69	3.7	57.1	71	2.6	51.9	21	-6.0
2	26.6	12	-3.5	32.5	25	-1.7	37.1	62	5.4	33.7	31	-0.6
1	26.9	2	-6.0	32.9	10	-5.2	37.6	24	-2.9	34.2	103	15.3

Table 59 demonstrates large differences between mild or no motor performance difficulty and achievement of the top levels of Dimension 5 (indicated by the adjusted residual scores of 5.0 and 8.6), and similarly between students with profound or severe impairment and performance at the lowest level (indicated by the standardised residual statistic of 15.3). In between these two categories, more students than expected with the profile of moderate impairment (requiring aids, cues, and prompts) were placed in Level 2 (adjusted residual score of 5.4), and there was an equal likelihood of students with mild impairments being placed in Levels 3 and 4 (standardised residual statistic of 3.7).

Summary of Findings in Relation to Impairment Severity and Scale Performance

This first set of tabulated results, relating impairment severity and support need to performance on the scale, associates severe impairment (measured by teacher report of need for extensive assistance) with beginning performance, and indicates that these items can be used to identify abilities in students with a wide range of performance difficulties as well as suggest specific and achievable learning targets to advance them.

Relationship of Bodily Location of Impairment to Scale Performance

As explained in the introduction, students nominated as having difficulties using their arms and fingers or gripping things were combined into an upper-body affected group, while

students with difficulties only in using their legs and feet made up the lower-body affected group for comparison. The particular interest of this analysis was differences in classroom physical functioning of students with upper (n=119) as opposed to lower (n=42) body impairment consistent with the extensive upper-body and fine-motor requirements of the classroom. In the figures 52 to 56 and tables 60 to 64 that follow, again, for each dimension the band-levels in ascending order are depicted on the y-axis, and the performances of students by their different functioning impairments are presented as bars on the x-axis.

Dimension 1: Balance, postural control, and positioning

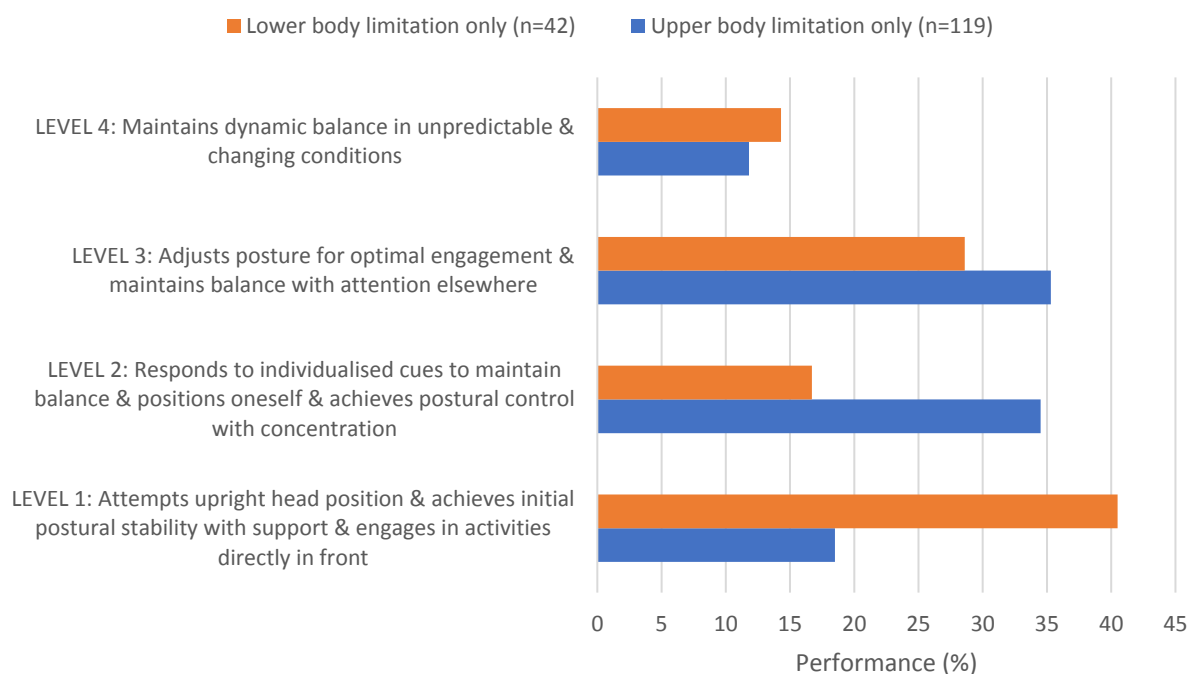


Figure 52. Dimension 1: Balance, postural control, and positioning

For Dimension 1, Figure 52 shows students with lower body limitation were more likely to be placed at the lowest level, and students with upper body limitation were located mainly in the middle two levels. Both groups appeared similarly to find the skills of the last level more challenging, involving balance in unstable task and environmental conditions (Gentile, 1987; Utley & Astill, 2008). This similarity is not surprising, given the tight connection of posture to both lower and upper extremity functioning (Harbourne & Kamm, 2015). In addition, as balance ability underlies all motor skills, it is assumed that level of functioning

reached on this dimension will be a factor in achievement on the other dimensions of the scale (Geuze, 2003; Shumway-Cook & Woollacott, 2012).

The Pearson chi-square value of 10.068 was statistically significant at probability level (alpha) of 0.02 (χ^2 [3; n=650] = 10.068; $p < 0.02$). Table 60 provides the score table for these two groups of students, highlighting which categories of results contributed most to the statistically significant Chi-square score.

Table 60 *Results by Impairment Location: Dimension 1 (Balance, Posture, Positioning)*

<i>Levels of Dimension 1:</i>	<i>Bodily Location:</i>					
	Upper body difficulties (n=119)			Lower body difficulties (n=42)		
	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>
Level 4	14.8	14	-0.4*	5.2	6	0.4
Level 3	39.9	42	0.8	14.1	12	-0.8*
Level 2	35.5	41	2.2	12.5	7	-2.2*
Level 1	28.8	22	-2.9*	10.2	17	2.9
<i>Total:</i>	<i>119</i>	<i>119</i>		<i>42</i>	<i>42</i>	

*Note: Negative scores indicate an inverse relationship between impairment location and performance.

From Table 60, large differences between observed and expected performance were seen between bodily location of impairment and scale placement at the lower two levels of this Dimension – students with upper body difficulties being more prevalent at the second level than expected (adjusted residual score of 2.2), and students with lower body impairments being more prevalent at the lowest level (adjusted residual score 2.9). In other words, at lowest levels, balance, postural control, and positioning posed relatively greater difficulty for students with lower body difficulties. At the same time, both groups of students were able to perform across the scale, including at the highest level. This was similarly reflected in Dimension 2, as Figure 53 shows.

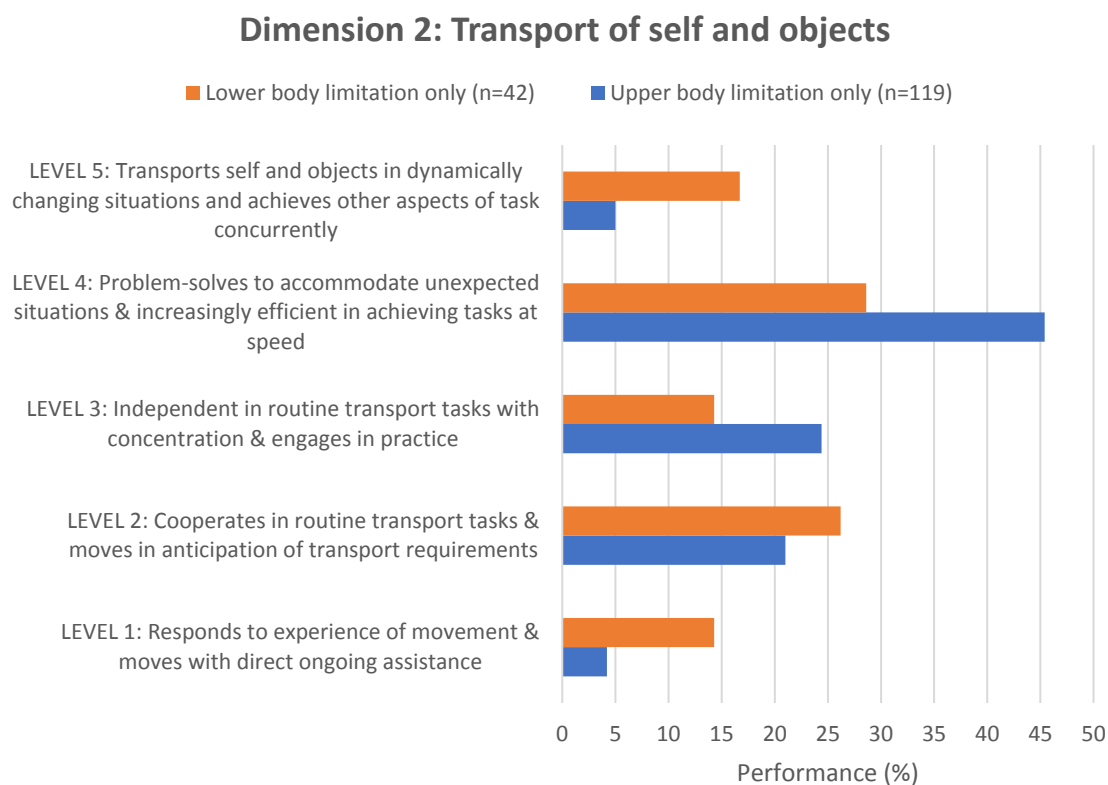


Figure 53. Dimension 2: Transport of self and objects

For Dimension 2, Figure 53 shows both sets of students were more likely to achieve the skills of Level 4, significantly so for students with upper body limitations who were also less likely to achieve the first and last levels. Students with lower body limitations performed more randomly across the entire Dimension.

The Pearson chi-square value of 13.780 was statistically significant at probability level (alpha) of 0.008 (χ^2 [4; n=650] = 13.780; $p < 0.008$). Table 61 provides the score table, highlighting which categories of results contributed most to this Chi-square statistic.

Table 61 *Results by Impairment Location: Dimension 2 (Transport of Self and Objects)*

Levels of Dimension 2:	Bodily Location:					
	Upper body difficulties (n=119)			Lower body difficulties (n=42)		
	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>
Level 5	9.6	6	-2.4	3.4	7	2.4
Level 4	48.8	54	1.9	17.2	12	-1.9
Level 3	25.9	29	1.4	9.1	6	-1.4
Level 2	26.6	25	-0.7	9.4	11	0.7
Level 1	8.1	5	-2.2	2.9	6	2.2
<i>Total:</i>	<i>119</i>	<i>119</i>		<i>42</i>	<i>42</i>	

From Table 61, differences of significance between observed and expected performance can be seen between bodily location of impairment and placement within this Dimension at the lowest and highest levels, with students with lower body difficulties more likely at the extremes of the scale (adjusted residual scores of 2.2 and 2.4). However, this was not the case for students performing at middle levels of ability. Overall, both groups were able to achieve across all levels, which was also the case for Dimension 3, as shown by Figure 54.

Dimension 3: Manipulation of objects and tools

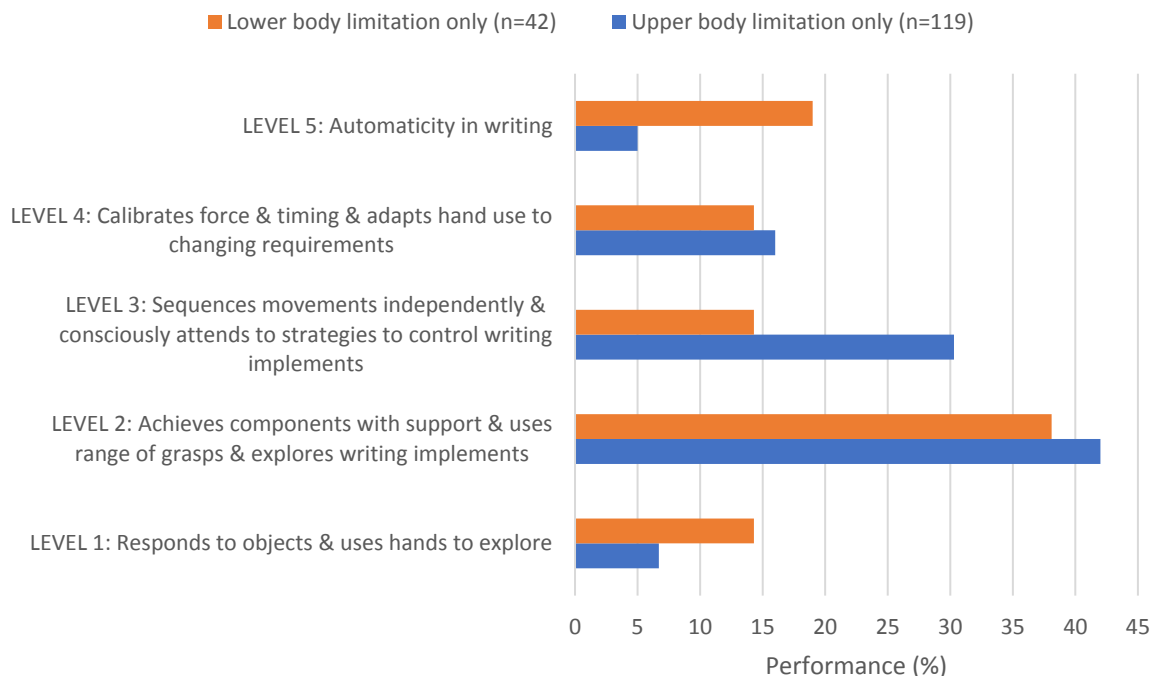


Figure 54. Dimension 3: Manipulation of objects and tools

Figure 54 depicts both groups of students scored predominantly lower on the scale – the Level 2 exploratory phase, while students with impairments to lower limbs only had greater likelihood of being placed at the highest level. This Dimension of fine-motor and object manipulation skills is very important to classroom functioning and the findings here relate logically to the impairment location, as it would be expected that students with upper body difficulties would struggle more to achieve these skills, though again, the data shows both groups were able to achieve across the scale.

The Pearson chi-square value of 343.109 showed statistical significance at a probability level (alpha) of 0.001 (χ^2 [4; n=650] = 343.109; $p < 0.001$). Table 62 provides the score table, highlighting which categories of results contributed most to this Chi-square statistic.

Table 62 *Results by Impairment Location: Dimension 3 (Manipulation of Objects and Tools)*

Levels of Dimension 3:	Bodily Location:					
	Upper body difficulties (n=119)			Lower body difficulties (n=42)		
	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>
Level 5	10.3	6	-2.8	3.7	8	2.8
Level 4	18.5	19	0.3	6.5	6	-0.3
Level 3	31	36	2.0	11	6	-2.0
Level 2	48.8	50	0.4	17.2	16	-0.4
Level 1	10.3	8	-1.5	3.7	6	1.5
<i>Total:</i>	<i>119</i>	<i>119</i>		<i>42</i>	<i>42</i>	

From Table 62, the largest difference between observed and expected scores were seen between bodily location of impairment and scale placement at the highest performance level – students with lower body difficulties being more prevalent than expected at Level 5 (adjusted residual score of 2.8), and students with upper body difficulties more prevalent than expected at the middle Level 3 (adjusted residual score of 2.0) – the skill level where achievement required focused concentration and attention to learned strategies. Support for relationship between performance and impairment type was also seen in Dimension 4, as depicted by Figure 55.

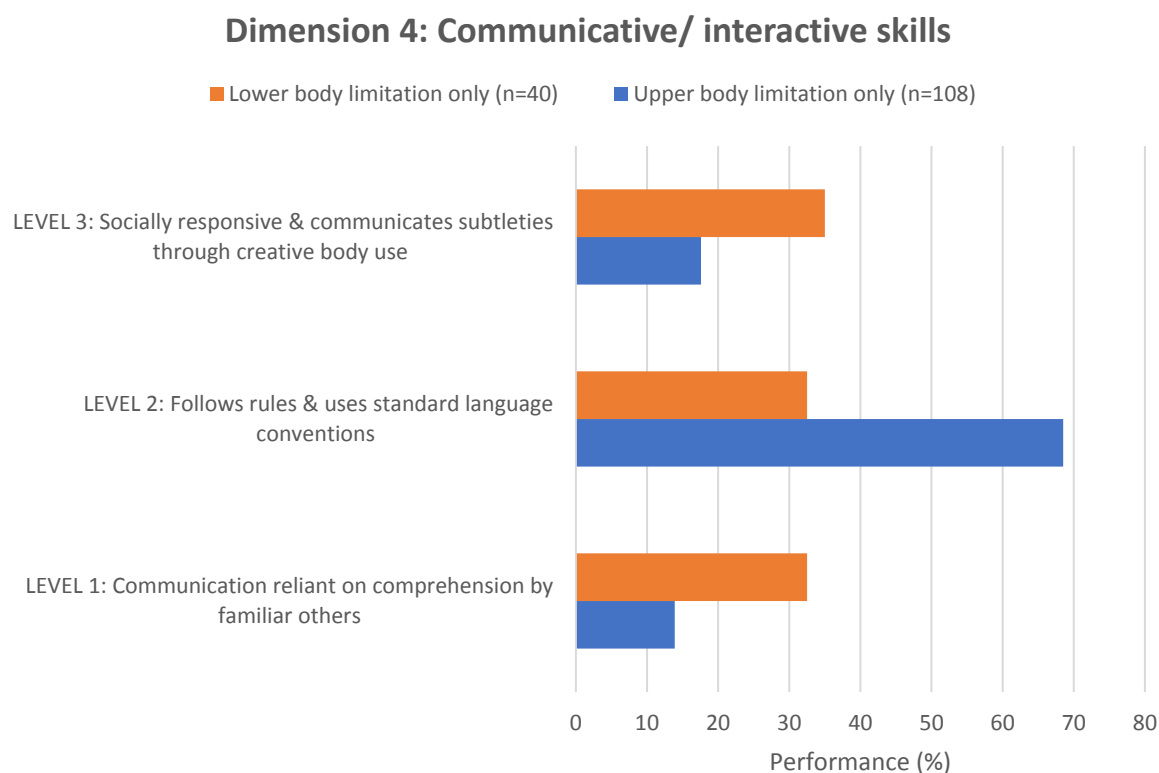


Figure 55. Dimension 4: Communicative/ interactive skills

Figure 55 indicated a greater likelihood of students with upper body limitations being placed at Level 2, while students with lower limb difficulties were evenly spread across the levels. It is possible that the inclusion of tension regulation, defined as “the ability to turn off the effects of stress at will” (Green, Green, & Norris, 1980), impacted results, as it is an aspect not related to either upper or lower limb functioning. Bodily tension exists as a constant background factor in conditions such as cerebral palsy and ADHD, as well as being impacted by the social environment of the classroom, with achievement of its regulation critical to self-expression and social confidence, as well as to maintenance of bodily equilibrium, management of feelings, and nervous system health (Carroll, 2008).

The Pearson chi-square value of 15.753 showed statistical significance at a probability level (alpha) of 0.001 (χ^2 [2; n=650] = 15.753; $p < 0.001$). Table 63 provides the score table, highlighting which categories of results contributed most to the Chi-square value.

Table 63 *Results by Impairment Location: Dimension 4 (Communicative/ Interactive Skill)*

Levels of Dimension 4:	Bodily Location:					
	Upper body difficulties (n=108)			Lower body difficulties (n=40)		
	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>
Level 3	24.1	19	-2.3	8.9	14	2.3
Level 2	63.5	74	4.0	23.5	13	-4.0
Level 1	20.4	15	-2.6	7.6	13	2.6
<i>Total:</i>	<i>108</i>	<i>108</i>		<i>40</i>	<i>40</i>	

The adjusted residual scores in Table 63 indicate that across all levels of this Dimension, student performance was significantly related to location of impairment. Particularly, while there was an even spread of students with lower body difficulties across the three levels (13, 13, 14), most students with upper limb difficulty were placed at Level 2, where performance required focused concentration to achieve outcomes and learning to apply standard language conventions. Figure 56 demonstrates a similar mid-level representation on Dimension 5 skills for students with upper body limitations.

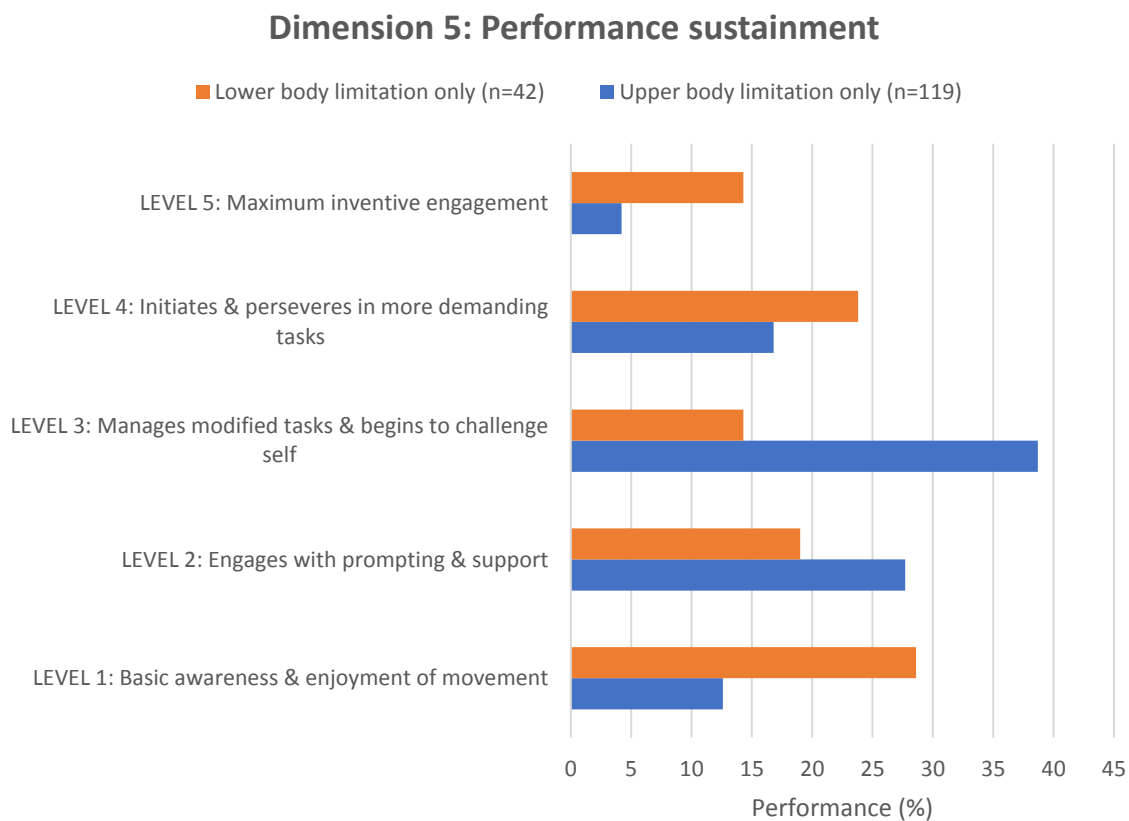


Figure 56. Dimension 5: Performance sustainment

Figure 56 demonstrates that for Dimension 5, students with lower body difficulties were represented across the levels, including the highest level, and that while students with upper limb difficulties were well represented at Level 3, their performance was also spread, particularly across the first four levels. The top level of this Dimension was characterised by motivated interest to move, strenuous engagement, and respect for one's physical limitations and wise use of one's resources. In this dimension, motivation to engage was a performance factor, with the research suggesting that mild physical disability negatively impacts motivation to move more than severe forms (Miyahara & Piek, 2006).

The Pearson chi-square value of 16.784 showed statistical significance at a probability level (alpha) of 0.002 (χ^2 [2; n=650] = 16.784; $p < 0.002$). Table 64 provides the score table, highlighting which categories of results contributed most to this Chi-square statistic.

Table 64 *Results by Impairment Location: Dimension 5 (Performance Sustainment)*

<i>Levels of Dimension</i>	<i>Bodily Location:</i>					
	Upper body difficulties (n=119)			Lower body difficulties (n=40)		
5:	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>	<i>Exp.</i>	<i>Obs.</i>	<i>AdjR.</i>
Level 5	8.1	5	-2.2	2.9	6	2.2
Level 4	22.2	20.0	-1.0	7.8	10	1.0
Level 3	38.4	46	2.9	13.6	6	-2.9
Level 2	30.3	33	1.1	10.7	8	-1.1
Level 1	20.0	15	-2.4	7.0	12	2.4
<i>Total:</i>	<i>119</i>	<i>119</i>		<i>42</i>	<i>42</i>	

Table 64 indicates an association between location of impairment and performance, particularly at Levels 1, 3, and 5. Students with upper body impairment were more likely to be found at Level 3, where greater preparedness to challenge oneself and undertake modified tasks began, while students with lower body impairments were present in greater numbers than statistically expected at the extremes of this dimension.

Using the Report to Analyse Profiles

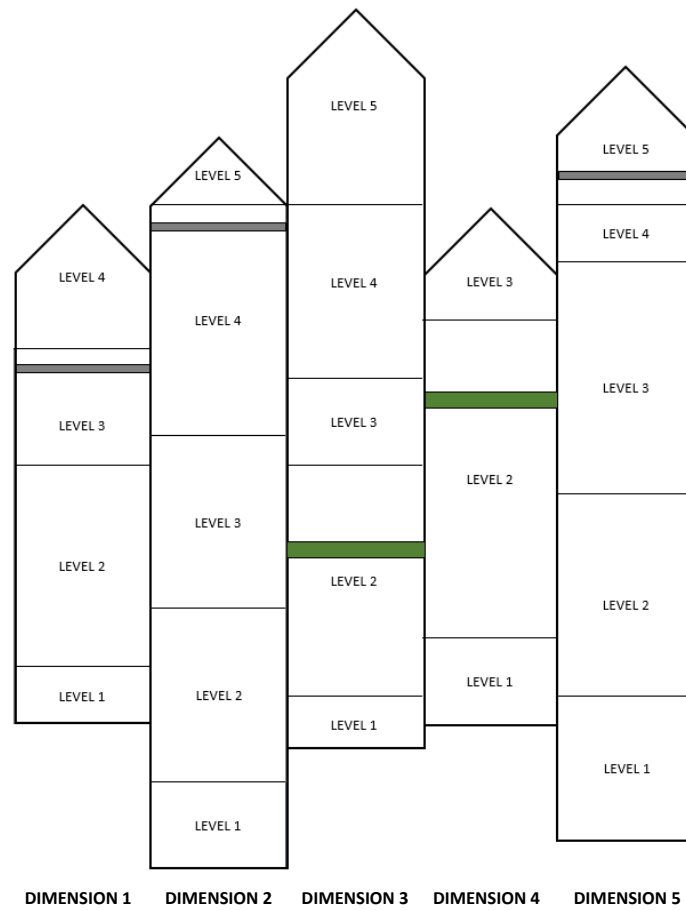
A case-study of two students assessed in the main study illustrates the usefulness of this standards-referenced, dimensionalised report for identifying areas for instructional intervention. The first is a 10-year-old male with ASD, intellectual disability, and difficulty with upper-body functioning – arms and fingers and gripping, but no assistance requirements in class. His score for the assessment was 43. The second is an 18-year-old male with physical and intellectual disability and difficulty with lower-body functioning, who requires assistance only for extended movement tasks in the classroom. His total score was 54. Placement of these students by score within the five dimensions is shown in Table 65 –

Table 65 *Dimension Scores for Two Students of Different Ability Profiles*

<i>Dimension</i>	<i>Description</i>	10-year old (upper body difficulty)		18-year-old (lower body difficulty)	
		<i>Score</i>	<i>Level</i>	<i>Score</i>	<i>Level</i>
1	Balance, posture, positioning	6	3	6	3
2	Transport of self and objects	11	4	12	4
3	Manipulation of objects and tools	7	2	15	5
4	Communicative/ interactive skill	6	2	8	3
5	Performance sustainment	12	5	13	5
<i>Total:</i>		43		54	

Table 65 depicts that significant differences in placement occurred only on Dimension 3 – demonstrating the ability of the dimensional reporting to differentiate between ability profiles relating predominantly to upper body functioning. In addition, though the 18-year-old scored similarly to the 10-year-old on Dimensions 1 and 2, these were the former's lower performing aspects – demonstrating the report's capacity to also pinpoint relative difficulty in relation to balance and mobility and trunk and lower limbs functioning. Figure 57 depicts these results – the report with green bars referring to the student with upper body difficulty, and the report with blue bars the student with lower body difficulty.

a)



b)

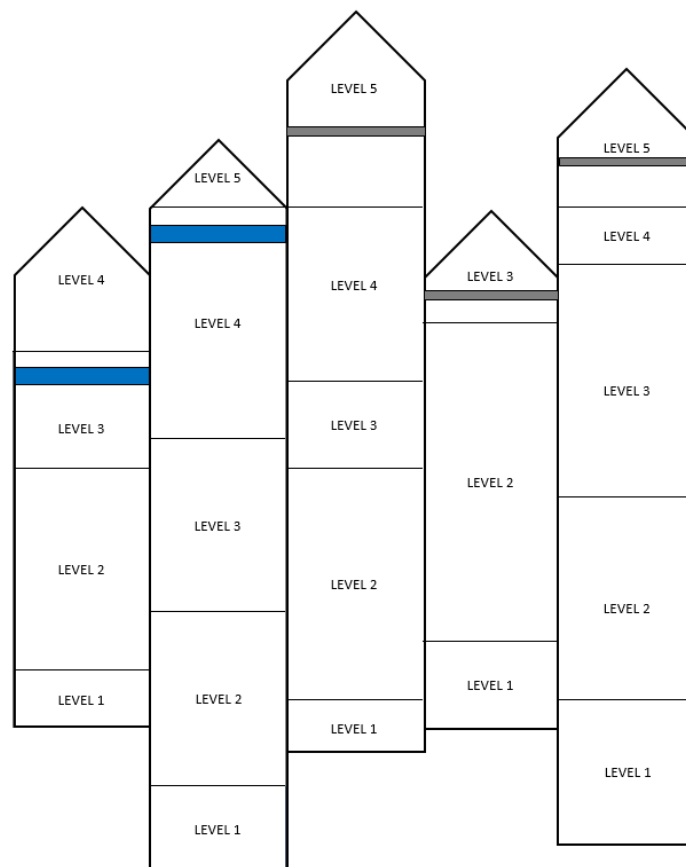


Figure 57. Profiles of two students – a) upper-body and b) lower-body difficulties

In Figure 57, the different start and end points for each 'rocket' depicts the range of scores and difficulty range of levels on the logit scale, with Dimension 1 at far left, moving across to Dimension 5 at far right. The bars indicate 50:50 performance, or the student's ZPD. In each case, this is the place of learning readiness where intervention is best pitched. Figure 57 illustrates that for the student with upper limb difficulties, Level 2 for each of Dimensions 3 and 4 would be the recommended focus, whereas for the student with lower limb difficulties, it would be Levels 3 and 4 of Dimensions 1 and 2. Figures 58 and 59 provide reports with these foci; the circled text showing appropriate learning challenges.

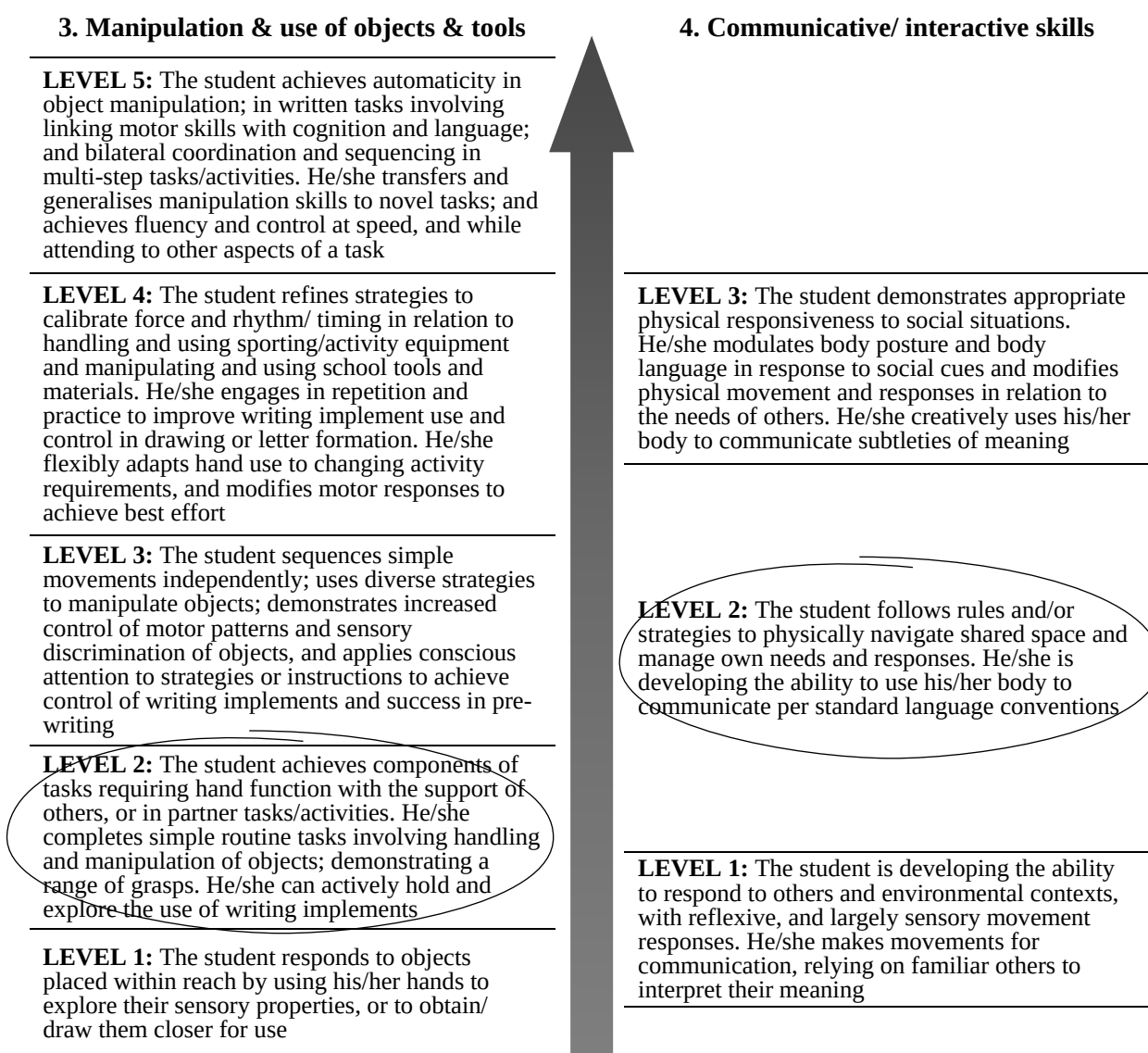


Figure 58. Report format showing focus areas for student with upper-body difficulties

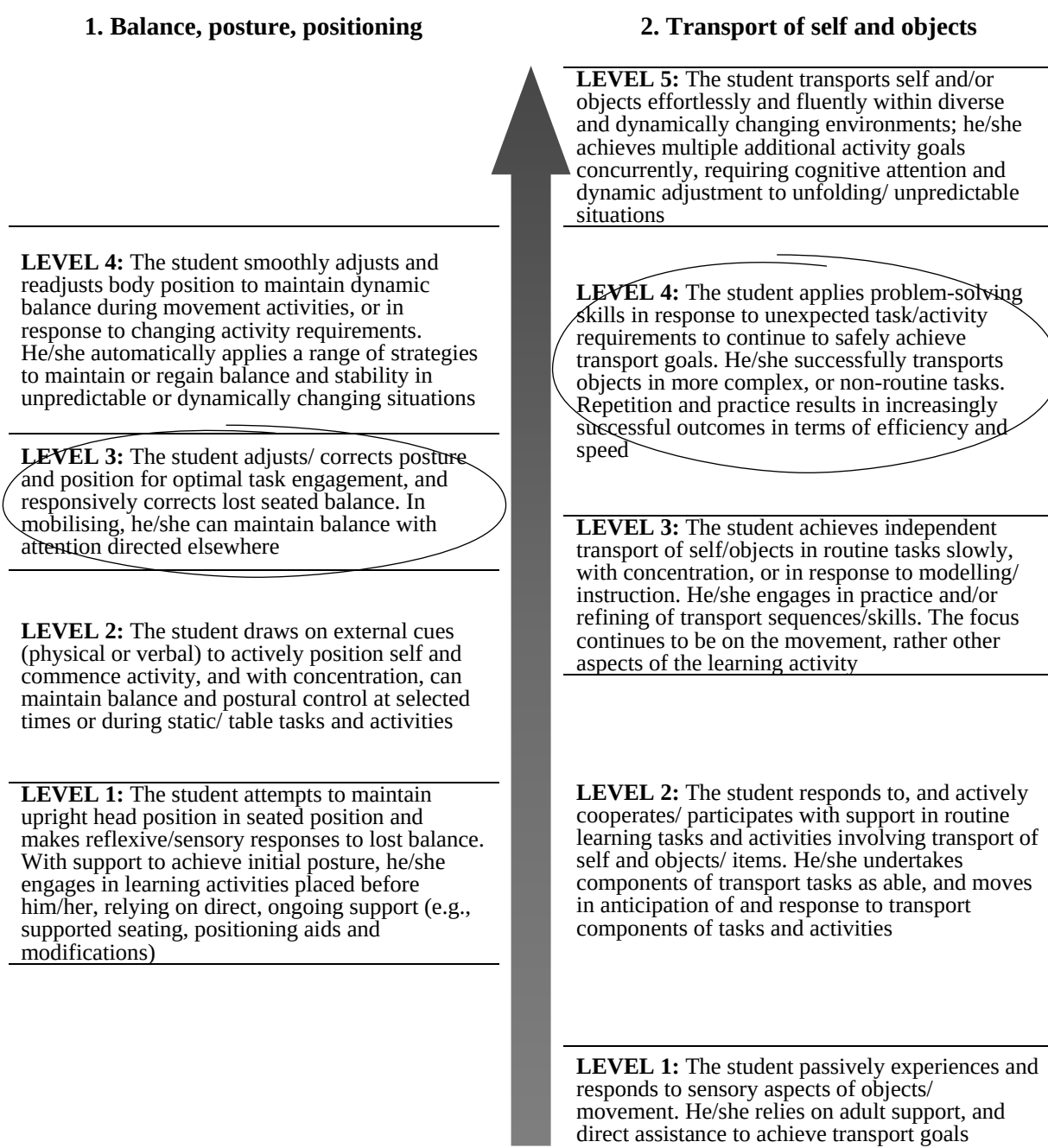


Figure 59. Report format showing focus areas for student with lower-body difficulties

Summary of Findings in Relation to Location of Impairment and Scale Performance

This second set of tabulated results relating bodily location of impairment to performance on the scale has indicated again that students with upper- or lower-body impairments can perform across the scale. Statistically significant associations between location of impairment and scale performance were less similar across the Dimensions than was the case

for the variable of impairment severity/ support need. Specifically, there was no or little significant relationship between upper body impairments and performance in relation to Dimension 2 (Transports self and objects), but significant association between upper body impairment and mid-level placement on Dimensions 3 (Level 3 placement more likely), 4 (Level 2 placement more likely), and 5 (Level 3 placement more likely). Lower body impairment showed a less consistent profile in terms of scale performance, particularly in relation to Dimensions 2, 4, and 5, where students with this bodily profile were statistically likely at either ends of the scale.

Chapter Summary

This cross-tabulation of variables relating impairment severity and bodily location to performance on the scale has demonstrated some elements of a relationship aligning to this investigation's starting assumptions and enabled response to the fourth research question. Firstly, a relationship between severity of impairment, identified as need for support in the classroom, and performance on the scale was confirmed. Partly this was due to referencing more difficult motor skills and movement examples at the higher stages, resulting in greater difficulty for students with motor performance difficulties to achieve these steps – for example, climbing stairs and orienting to gravity during unstable activities (Item 1), reaching accurately at different speeds (Item 5), releasing objects accurately while attending to next task steps (Item 12), maintaining legible handwriting at speed (Item 13), and completing strenuous activities at speed (Item 19). At the same time, advanced performance was also described as increasingly proficient problem-solving capability that did not require intact physical infrastructure but the process of learning to get the most out of the body one had – for example, anticipating and adjusting position (Item 4), practicing moving (Item 3), modifying movement to benefit from prior learning (Item 7), concentrating to achieve movement goals (Item 10), exploiting movement possibilities afforded by body, environment,

and task (Item 11), moving responsively or cooperatively (Item 14), and planning movement to achieve maximal engagement (Item 18). In relation to these skills, providing more practice opportunities during classroom performance and reducing over-help would support skill development (McDonald et al., 2001).

Secondly, there was some evidence that upper-limb difficulties contributed to reduced classroom performance, particularly in relation to Dimensions 3 (object control and manipulation skills), 4 (manual coordination skills for self-expression), and 5 (fitness/endurance, and interest/motivation capacities), where in each case, the likelihood was placement at the level where successful performance required focused concentration on the movement. This has broad potential impact, as when students are still at the stage of *learning to move*, they are disadvantaged in dual-task situations where their peers are *moving to learn* and can accommodate additional task requirements (Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010; Piek et al., 2008; Vuijk et al, 2011). A perspective of this study is that object control and manipulation skills, due to their role in learning, should be considered as a cross-curricular learning area, with the goal to better support students whose motor and academic learning is negatively impacted by insufficient instructional focus and support to advance.

Chapter Ten: Discussion and Conclusion

This chapter is divided into three sections. The first section presents a review of the rationale and methodology for the investigation. The second section discusses the results in relation to the research questions and identifies the theoretical and practical implications. The third section provides conclusions and suggestions for future research.

Overview of Investigation and Methodology

Review of Rationale and Aims

The main purpose of this study was to determine a learning progression for goal-directed movement to enable identification of next learning stage for students with motor performance needs. Two rationales informed this research: the first relating to classroom movement requirements and the motor learning needs of students with impaired movement, and the second relating to the uses of occupational therapy assessment results to support intervention planning and interactions with children as learners in classroom settings marked by curricular, or developmental learning paradigms and approaches.

Firstly, regarding the motor learning needs of students with movement difficulties, at the time of this investigation, Australian pre-service and in-service teacher training did not include development of skills and knowledge to support this learning, nor was the area constituted as a curriculum domain. However, there was precedent for considering a curriculum development approach in the development by Victorian and Australian Curriculum authorities of other foundational skill areas as “areas of learning in their own right”, which supported teachers to target their instruction of students whose learning in those areas was not occurring naturally (Howes, 2012, p.8; see also ACARA, 2010 to present; Australian Government DET, 2015b). Curriculum resources had been developed for Literacy, Numeracy, Information and Communication Technology Capability, Critical and

Creative Thinking, Personal and Social Capability, Ethical Understanding, and Intercultural Understanding. However, no learning progression in functional, or goal-directed movement had been attempted, despite being noted as a foundational “serving competency” (Bailey, 1984, p.80; see also Allan, 2011, Anderson & Boyle, 2015), and its responsiveness to instruction as a learning domain (Ahmadi, Hasan, & Hosin, 2012; Bernstein, 1996; Carr & Shepherd, 2006; Latash, 2007; Latash & Nicholas, 1996; Logan, Robinson, Wilson, & Lucas, 2011; Thornton, Licari, Reid, Armstrong, Fallows, & Elliot, 2016). Research indicating associations between physical capacities and academic attainment suggested value in addressing this area educationally, rather than, in all instances, arranging task and environment modifications to lessen or remove their motor aspects (Asbjornslett & Hemmingsson, 2008; Clark et al, 2007; Pratt & Peterson, 2015; Sugden et al., 2008).

Secondly, of the paediatric occupational therapy assessments of motor skill reviewed, none were found underpinned by a “strong model of progression in learning” (Wilson, 2009, p.7). Assessments so underpinned are advocated in education – involving, firstly, description of pathways along which learning typically proceeds, and secondly, use of those pathways to devise assessment items permitting level of performance, or learning stage, to be ascertained (Griffin, 2007; Wilson, 2005). In contrast, existing judgement-based assessments of classroom motor performance for teacher use reviewed in this research (i.e., the ChAS-T [Rosenblum, 2006], HPSQ [Rosenblum, 2008], MOQ-T [Schoemaker, 2003], MSRS [Cameron et al., 2012], MABC-2 Checklist [Henderson et al., 2007], SFA [Coster et al., 1998], and TEAF [Faught et al., 2008]) contained various lists of movement outcomes both desired (e.g., ‘walking about without bumping’; ‘ties own shoes’) and undesired (e.g., ‘moves like a younger child’; ‘poorer handwriting than peers’), and while some had used IRT to construct difficulty hierarchies of items suggestive of learning advance, their Likert-type rating scales did not describe progressively sophisticated responses. Instead, early options

described degrees of *non-achievement* ('deficient', 'ineffective', 'questionable', 'inconsistent', 'not to peer level'), followed by single, notional *achievement* descriptions ('effective', 'readily and consistently achieves', 'consistent performance'). Consequently, while results established competence in the skills assessed, they did not establish *learning* performance levels, nor provide guidance to learning intervention planning teams to advance learning.

In response to these concerns, this study investigated the extent to which an acquisitional learning sequence in classroom-related goal-directed movement could be positively described and used to identify learning readiness for students with motor performance needs. This required, firstly, establishing and calibrating the construct as a learning progression consisting of meaningful performance transitions in important, indicative skills as determined through the literature and subject matter expertise. Secondly, it involved confirmation of sub-dimensions, as it had been suggested by the research that these underpinned different "profiles" of motor ability in the population (Bernstein, 1996, p.210). Thirdly, it involved determining major stages of skill acquisition and implications for reporting and, finally, it required consideration of the impact on performance of different degrees of impairment severity and their bodily location. The research questions addressed these aspects sequentially:

1. What is the typical developmental learning progression for goal-directed movement?
2. To what extent is the developmental learning progression for goal-directed movement a multidimensional construct?
3. What are the major stages of skill acquisition in the development of goal-directed movement for students with motor performance needs, and how are results best reported for different stakeholder groups?
4. How do the background characteristics of the students influence the development of goal-directed movement in students with motor performance needs?

Review of Methodology

Data collection procedures. A multidimensional learning progression was developed and formatted for online delivery as a judgement-based observational questionnaire. The sampling design for calibration sought representative spread of age, gender, impairment severity, and impairment type in school-aged children with motor performance needs.

Ninety Victorian special schools and 29 mainstream schools were invited to participate in this study. Of these 90 schools, 46 special schools and 7 mainstream schools took part. Within these 53 participating schools, 219 staff members volunteered to participate in the study as ‘assessors’, most being classroom teachers (86%). A total of 650 students were assessed by these 219 assessors, hence some assessors rated more than one student. The student sample consisted of 226 females (35%) and 424 males (65%), with an average age of 11 years ($SD=3.9$ years). In terms of impairment severity, the students assessed were evenly spread, with 25% needing extensive classroom help or supervision, 27% dependent on aids, cues, and prompts, 24% independent in routine, non-extended classroom tasks, and 24% requiring no support in the classroom. In terms of functional impact, 70% had difficulties with their upper body and 35% with their lower body. Further details of the sample are provided in Chapter Six. The 219 assessors rated the students’ motor skill problem solving ability on 19 items. This involved selecting, from three to four unique performance descriptions, the highest level the student had been observed to perform or manage in class.

Scale development procedures. The instrument design methodology employed in this study utilised a combination of theoretical and psychometric approaches to scale development as described in detail in the methodology Chapter Five. This set out the processes followed to develop the underpinning learning progression enabling students to be placed along it at their point of current achievement (Griffin, 2007; Griffin et al., 2004; Wilson, 2005; Wolfe & Smith, 2007).

Drawing on the motor control and learning literature, the construct was firstly defined relative to the target group, and its main aspects and indicators identified from the literature (for example, Bernstein, 1984, 1996; Campbell, 2012; Gentile, 1987; Newell, 1991; O'Brien, 2015; Shumway-Cook & Woollacott, 2012; Utley & Astill, 2008; Westcott McCoy & Dusing, 2012). This initial mapping was developed further by a subject-matter expert (SME) group consisting of educational and health practitioners with extensive classroom experience with students with motor performance needs. In collaboration, these SMEs devised a set of skills and performance indicators describing the different aspects of motor skill problem solving and subsequently ranked these against each other to hypothesize the latent trait. Processes of panelling, piloting, and trialling followed, involving renovations and additions to the original item set. Following the data-collection main study, tests of dimensionality were conducted.

Data analysis procedures. Analysis of the survey data utilised the partial-credit model (Masters, 1982), which applies the dichotomous Rasch model (1980) to items with more than two ordered response categories, or item proficiency steps (Wu & Adams, 2007). Two IRT analyses were conducted on the results, utilising ACER ConQuest IRT software (Adams et al., 2015) – firstly, a unidimensional analysis, and secondly, a between-item multidimensional analysis, using the multidimensional random coefficients multinomial logit model (MRCML) (Adams et al., 1997).

The unidimensional analysis established the extent of achievement of a unidimensional skill progression, providing most probable score regions for the unique qualitative response categories of the skills in an extension on conventional health assessment use of the partial credit model to analyse rating scale data. Extent of invariance of the items for the target group was also considered through an examination of differential item functioning (DIF) using infit statistics.

Between-item multidimensional analysis pre-loads items onto single dimensions to identify measures of performance across different content areas, not in a negation of unidimensionality but to enable exploration of different profiles of ability in situations where items model the construct directly (Hartig & Hohler, 2009). Allocation of items to dimensions was made not only to the five dimensions used to devise the item set, but a three-dimensional alternative also supported by the literature. Relative fit of these configurations to the structure of item responses was ascertained by comparing fit deviations, ensuring consideration of both statistical and end-user requirements.

The influence of impairment characteristics on scale performance - impairment severity, and location of functional impact (upper- or lower-body) - was examined via contingency tables and the presence and strength of this relationship across the 22 standards of the five dimensions was established using Pearson's chi-square test for independence. The capacity of the scale to identify beginning skills in students with profound or severe levels of impairment, as well as to provide next steps for students with only mild motor performance difficulties, was also established by these cross-tabulations.

Standard setting procedures. Detail of the processes for achieving a standards-referenced scale were set out in the methodology Chapter Five. Standard setting establishes by common judgement the cut scores and boundaries around categories of performance from assessments, enabling students to be placed into performance bands and permitting instruction to target their learning level (Cizek & Bunch, 2007). Rasch modelling of items can help improve the standard setting process by providing the difficulty order of the items (McCann & Stanley, 2006). The goal of identifying starting points for learning and supporting intervention planning required provision of standards for the dimensionalised scale and enabled the possibility of reporting results that incorporated performance summaries. Bookmark standard-setting methodology was followed (Cizek & Bunch, 2007),

and a Delphi panel for achieving consensus among experts was convened (Dalkey, 1969), consisting of five paediatric occupational therapists experienced in classroom-related motor skill development. These experts worked with the researcher across three iterative rounds to identify the significant shifts in ability for each of the five dimensions and determine the optimal reporting formats for different stakeholder groups in this interdisciplinary work setting. Consensus was achieved for between three and five levels per dimension, permitting more detailed identification of profiles of ability in the target group.

Review of Key Findings

In this section, key findings from the research questions are presented, with discussions and implications for future research following.

Research question 1.

What is the typical developmental learning progression for goal-directed movement?

Firstly, in terms of an acquisitional sequence for the construct, the use of IRT enabled the construction of proficiency indicators, or rubrics for each of the 19 goal-directed movement skills, consisting of three to four observable descriptions of increasingly competent behaviour. Teachers were able to use this judgement-based questionnaire to grade students' movement competence, with the result, when calibrated, of a single acquisitional sequence of 63 goal-directed movement skills with an average score of 31 (SD=15) and a standard error of measurement of 2.65. Mean item difficulty was 0.07, just above mean ability of students (constrained to zero for IRT calibration). The CTT coefficient alpha (Cronbach's α) and IRT person separation reliability were high at 0.97, indicating very good test reliability. As Davenport and colleagues note, " α approaches 1 when differences in observed scores are primarily due to the fact that examinees differ on their true scores" (2015, p.4). Hence, these statistics indicated the dependability of this as an acquisitional sequence differentiating between students on their ability in the construct.

Secondly, in terms of instructional usefulness, the modelling of item responses on an underpinning developmental learning framework for the domain ensured results supported instructional next steps, because the instrument located students within the learning progression, not in relation to the performance of others. In other words, by bringing educational practices of learning progression construction to health assessments traditionally framed to contrast disabled and able-bodied functioning, assessment results could indicate both capacity reached and next intervention focus (Wilson, 2009). This was proposed as a support to health-educator collaboration in educational settings as it would enable engagement with students as learners by all members of their learning support teams.

Thirdly, in terms of the appropriateness of item difficulty and type to the target group, the instrument was found to target the sample of students well in terms of matching difficulty levels of the full spectrum of student ability and provided a range of item difficulties at each level, particularly those at the lowest level. Students with motor impairments of a wide range of types and severities were able to achieve across the scale without their impairments causing discrimination - lowest performers could achieve a score, and highest performers could achieve 62 of the 63 item-steps. This was the result of conceiving movement along Bernstein's (1996) functional and ecological lines as a disability-accessible activity of repeated solution-finding or problem-solving, rather than a normative output performance. Sampling beyond the target group for the trial demonstrated an invariant item set for all but Item 1 (Maintains balance and upright posture), supporting the measure's internal structure validity (AERA, APA, & NCME, 1999; Downing, 2003; Messick, 1995; Tennant & Pallant, 2007). In addition, despite Item 1's differential item functioning, this did not contribute to differential test functioning, or inequality of testing outcomes (AERA, APA, & NCME, 1999), one reason being that decreased likelihood of achievement on Item 1 was offset by increased likelihood of achievement on Item 15 (Moves for self-expression and

communication). At the same time, reference in the scholarly literature to associations of balance with other movement aspects (Shumway-Cook & Woollacott, 2012; Sibley, Beauchamp, Van Ooteghem, Straus, & Jaglal, 2015) indicated value in testing the fit of items to a multidimensional IRT model.

As well as improved item fit, the likelihood was that reporting results along multidimensional lines would increase the information available to intervention decision-making, as it would prevent important ability differences being “washed away in the composite” (Burton & Rodgerson, 2001, p.353). In other words, having drawn upon dimensional considerations to draft the items, there was a rationale to elicit maximum information around dimensional performance from the results to guide instructional decision-making. A multidimensional report would support this goal, as it would enable variation in ability across the scale to be identified, and ensure pertinent aspects received intentional focus in busy classrooms.

Research question 2.

To what extent is the developmental learning progression for goal-directed movement a multidimensional construct?

While an important criterion for interpretability of test results is that variance in results be attributable to one factor, this does not necessitate strict unidimensionality across all domain aspects (Cronbach, 1951; Davenport et al, 2015). In the case of this investigation, while the items all related to goal-directed movement, they had sampled from five of its important dimensions as identified by the scholarly literature and expert opinion – 1) balance and postural control, 2) transport of self and objects, 3) manipulation and object control, 4) communicative and interactive skills, and 5) performance sustainment. Therefore, an analysis of between-item dimensionality using the MRCML IRT model was conducted,

loading each items' partial-credit proficiency steps onto its respective sub-dimension to establish overall best fit (Adams et al., 1997; Wu et al., 2016).

There was some difficulty establishing allocation to dimensions as, within the unique qualitative response categories provided for each item, examples of ordinary classroom tasks had been provided to aid teacher identification of student capacity and, being 'real-life', these often drew from across dimensions. To complete an item, teachers firstly considered the skill, then answered on the basis of the highest proficiency step they had observed the student accomplish, using the examples to help them. A confirmatory purpose for the multidimensional analysis was to ascertain whether the assumptions of dimensional placement held despite these cross-dimensional examples at the proficiency step level. However, exploratory analysis was also needed, testing different item combinations within the categorisations suggested by the literature. The complexity with this highlighted the need for careful item construction, so that at each level of description (item, proficiency steps, and examples) there was clear internal coherence and strong connection to the overarching dimension.

At the end of this process, the five-dimensional between-item model improved the fit of Items 1 (Maintaining balance and upright posture), 2 (Regulating physical tension), and 15 (Moving for self-expression and communication) on both the unidimensional model and an alternative three-dimensional version also suggested by the research, suggesting that the fit to the five-dimensional model was not due to chance. In the five-dimensional model, Item 1 became combined with Item 4 (Positioning to engage in activity), to constitute a Balance, Posture, and Positioning dimension, and Items 2 and 15 were combined with Item 14 (Sharing space interactively), to constitute a Self-expression and Social Interaction dimension. The consequent improved fit of these items supported the hypothesis of Chapter Seven that skills with complex associations are better loaded onto their own ability

dimensions. Otherwise, for example, if posture and balance results were scored with mobility skills, relative strengths and difficulties in each would not be able to be differentiated by the assessor, with consequent impact upon item-fit.

One further item that showed some evidence of misfit was handwriting Item 13, which ended in the five-dimensional analysis only just within acceptable range. As the Delphi panellists' amendment suggestions for this item occurred after the data collection period and this is a significant aspect of classroom skill, a recommendation for future work is to conduct a calibration of the measure including this amended item, establishing its derived placement and evidence of improved fit.

Lastly, reporting results against dimensions enabled the possibility of discriminating between different ability profiles. To achieve this in a way useful to instruction, however, the identification of stages of transition, or provision of standards for the scale was needed, and determination of reporting formats that maximised the relevant information obtainable from results.

Research question 3.

What are the major stages of skill acquisition in the development of goal-directed movement for students with motor performance needs and how are results best reported for different stakeholder groups?

Having empirically established an acquisitional sequence of goal-directed movement skills and divided these across five sub-dimensions according to best fit and the insights of research and practitioners, a Delphi panel of occupational therapy experts worked according to Bookmarking methodology to set its standards. The ability of this group of experts to reach consensus on cut-points and standards for a dimensionalised scale they had not been involved in developing supported the nature and existence of these levels across the measure. The result was 22 discrete performance standards that provided a rich description of the

nature and process of learning in the domain, supporting the insights of the literature as to how motor learning progresses and its features at different learning stages (see Chapter Eight for a detailed analysis of findings). The descriptions of stages involved both common features expressing the overall unidimensionality of human movement and aspects pertinent to each sub-dimension, enabling reporting along both stage and dimensional lines to permit descriptions of different profiles of ability (Bernstein, 1996).

One aspect that received considerable attention during review of the literature was the nature of the presence of cognition in motor learning, as this was seen to have implications for application in an educational context. The “shift to automaticity” noted in the research (Shumway-Cook & Woollacott, 2012, p.92; see also Fitts & Posner, 1967) and in dynamic-systems approaches to motor skill acquisition (Thelen & Bates, 2003) had been proposed as relating particularly to achieving skilled *repetitive* movement – Bernstein’s lower levels of tonal contractions and muscular synergies (Bernstein, 1996), while other research had underlined the ongoing requirement for cognition in movements that were discrete, complex, or involved strategy formation (Keele, 1998; Summers & Anson, 2009). Bernstein’s conception of movement problem-solving expressed this more cognitive aspect. Karmiloff-Smith’s developmental theory of “representative redescription” enabled many threads to be drawn together – identifying automaticity with a first phase of ability but noting that specifically human development reached beyond this and involved a search for understanding and not simply technique, and that this required ongoing cognitive internal reorganisation to increase the usability of skills and knowledge already achieved and automatized (1981, 1992, 1994). The upshot of this was support for this investigation’s learning progression approach, including the idea of stages of acquisition rather than single ‘arrival’ points, and the incorporation of both elements of automaticity (e.g., achieving smoothly repetitive locomotor movement) and cognitive reengagement with those skills at higher levels to expand their

strategic use. Results from the study supported placement of both aspects at highest levels, with the top skill (13.4) involving legible and fluent handwriting under demanding conditions - a task requiring both cognitive attention and automaticity of the underlying skill set, the second highest skill (19.4) involving maintenance of strenuous activity while attending to other task aspects - an expression of automaticity, and the third highest skill (17.4) involving planning for movement adaptations – requiring forethought. An important consideration in relation to the thinking aspects of movement and its consideration as a classroom learning domain is that, at lower levels of movement proficiency, the amount of conscious attention required to perform movement reduces the number of other aspects able to be attended to (Shumway-Cook & Woollacott, 2012). Teachers therefore need to consider when to focus on movement learning, and when to remove movement requirements to focus on academic aspects requiring all of one's concentration. In this way, motor learning can take place in the context of meeting other learning needs.

With regards to report formats, panellists agreed that the gist level rocket report was insufficient for planning purposes but met requirements for a simple reporting of current performance to stakeholders such as parents and school leadership, and predominantly agreed that the itemised test report format provided most help to teacher non-specialists in the motor domain. The dimension report developed through this research study was recognised as most helpful for intervention planning and preferable to the itemised test report format by just over half (three out of five) of the panellists, while an ongoing interest in using results of criterion-referenced assessments as checklists for intervention was evident in some comments. Hence, while occupational therapists recognised their greater expertise, their different conclusions about report formats most helpful to them and teacher non-specialists in the motor domain meant definitive conclusions could not be drawn. A consideration in this regard, and leading

to the final research question, was the extent to which a multidimensional and standards-referenced report could clarify profiles of ability and support personalised intervention plans.

Research question 4.

How do background characteristics influence the development of goal-directed movement in students with motor performance needs?

Two hypotheses were developed about scale performance and presence of motor difficulties - firstly, that impairment severity - identified by support requirements in the classroom - would impact placement on the scale overall and, secondly, that functional impact of impairment would impact dimensional performance, particularly in relation to upper-body impairment and Dimension 3 - the dimension concerned with manipulation and use of classroom equipment, including handwriting tools. Results indicated statistically significant relationships in both these regards.

In relation to impairment severity, decreasing support needs and higher scale placement were strongly associated. However, lack of practice opportunity as a causative factor was not established by these results, which could only be said to bear out common-sense assumptions that the more impaired the motor function, the more difficult the execution of motor tasks. The role of practice in this - the extent to which performance opposite to expectations was or could be achieved through practice - required more detail in the student questionnaire, and suggested value in a follow-up study working with students with low initial scores to determine if, and in what way, classroom practice could lift these.

In relation to bodily location of functioning difficulty and classroom performance, results bore out expectations particularly for Dimensions 1 (Balance and positioning) and 3 (Object control, manipulation). In relation to Dimension 1, students with upper-body impairments demonstrated higher performance (Level 2) than students with lower-body impairments (Level 1). In relation to Dimension 3, the reverse was true – students with upper-body

impairment demonstrated lower performance (Level 3) than students lower-body impairment (Level 5). Less clarity was evident for relationships between functional impairment and performance on the other Dimensions.

Contributions to the Fields of Practice and Research

Drawing together threads from the previously described findings and results, two main reflections are offered regarding the contributions of this research – firstly, in relation to occupational therapy practice and secondly, in relation to education.

Contributions to Occupational Therapy

Firstly, this research has the potential to contribute to the capacity of school-based occupational therapists to support the important occupational roles of students with motor learning needs, by supporting therapists to more consistently intersect with children as *learners*. This has been achieved by drawing on educational measurement theory to construct a learning progression in the movement requirements of the classroom – an area of occupational therapy responsibility. School-based occupational therapy has an expressed commitment to “educationally relevant therapy services” that support students as students and seek to avoid therapy in-roads into the classroom (Simmons-Carlsson, Hocking, & Wright-St. Clair, 2007, p.6; see also Benson, Szucs, & Mejasic, 2016; Truong & Hodgetts, 2017; Wintle et al., 2017). These services include skill and capacity development in relevant aspects of physical functioning (Mancini & Coster, 2004), however, in a review of the literature, the development of these areas as learning domains with underpinning learning progressions was not found. The position of this research has been that such development would better support the profession’s commitment to occupationally embedded practice and to fostering occupational roles (Hinojosa, Kramer, & Royeen, 2017; Molineux, 2004; Wilding & Whiteford, 2009). In school-based settings, children, occupationally, are learners; hence any intervention to support academic achievement should also engage with them as

learners. Chapter Two's literature review noted that, without this commitment, the focus in therapy has tended to be on deficit-remediation and to involve performance comparisons to neurotypical peers (Molineux, 2004; Townsend & Wilcock, 2004). In illustration of this practice, Chapter Four's review of school-based occupational therapy assessments noted the consistently norm-referenced or norm-like nature of the assessment rating scales. As Wilcock (2005) has stated, "many occupational therapists... define health in functional terms with disability in mind, or at least, work unconsciously to that definition" (p.6). When rating scales reference same age-grade or neurotypical expectations at their top level, it is proposed that disability is in view, and identification of deficits rather than positive identifications of learning stage. Through this study's construction of a developmental learning progression 'underpinning' for assessment, an expansion of assessment purpose in school-based therapy to include learning stage identification has been operationalised. Hence, more than a diagnostic test, the result can serve a formative function.

Secondly, the findings of this study offer a critique to assumptions of occupational therapy and rehabilitation that learning intervention begins with selection of teaching strategies, or the therapist's own contribution to the change process (Greber et al., 2007), rather than with a more person-centred concern for how progressive change and conceptual reorganisation occurs in the recipient (Wilson, Bejar, Scalise, Templin, William, & Irribarra, 2012). It has argued, instead, that intervention must begin with accurate understandings of the present knowledge/ skill of the student and what is ready next to be learnt – in other words, with assessments of learning progress that identify intervention starting points (Griffin, 2007, 2018; Masters, 2013; Pellegrino et al., 2001; Wilson, 2009). Without establishing this, a gap exists between problem lists generated by assessments and intervention strategies selected in response (Dijkers, Hart, Whyte, Zanca, Packel, & Tsaousides, 2014b). The developmental learning framework of this investigation, drawn

from Griffin's (2007) synthesis of the work of Vygotsky (1978, 1993), Glaser (1963, 1981), and Rasch (1980), has demonstrated how assessment and intervention can be more closely linked, and intervention can more closely meet the demands of the person-centred approach (Nilsson & Townsend, 2010; Townsend & Polatajko, 2007). It has also suggested an assessment approach that supports therapists to intersect with students as learners and to work within learning-based models of intervention, consistent with the understanding that client learning is a central mechanism of action in rehabilitation (Carr & Shepherd, 2006; Dijkers et al., 2014a; Ehlhardt et al., 2008; Gordon & Magill, 2012; Greber et al., 2007; Hart, 2011; Hart, Ferraro, Myers, & Ellis, 2014; Hart, Tsaousides, Zanca, Whyte, Packel, Ferrero, & Dijkers, 2014; Whyte & Hart, 2003).

Finally, through its application to the motor domain of procedures for designing assessments of learning in education (Griffin, 2007; Griffin et al., 2004; Wilson, 2005), a contribution to cognitive and dynamic systems understandings of motor skill acquisition is suggested. Results from the calibration with school-aged students with motor performance needs indicate that developing motor skill can be expressed both as increasingly unconscious automaticity as well as quick-witted resourcefulness that seeks greater usability and intentional, creative application of what has already been acquired (Karmiloff-Smith, 1981, 1992, 1994). This combined capacity has also been identified as possible and learnable by students with a wide range of motor performance needs, adding to the research findings on intact task-specific motor learning capacity for this cohort (Effgen, 2013; Houwen et al., 2014; Latash, 2007; Polatajko & Mandich, 2004; Rivard et al., 2012; Shepherd, 2007).

Contributions to Education

This research has the potential to support classroom teachers to intersect educationally with students with motor learning needs, through the same provision of a learning progression in classroom goal-directed movement.

Reviews of curriculum documents, assessment tools, and the scholarly literature highlight the range of motor skills required for classroom performance (Chandler & Clark, 2013; Coster et al, 1998; Fisher et al, 2007; Hinder & Ashburner, 2010; McHale & Cermak, 1992; Rosenblum, 2008), and the associations of motor performance with academic achievement (Faught et al, 2008; Schoemaker et al., 2012). Many students experience difficulties with these tasks, as noted in Chapter Two's literature review (e.g., Chung & Patel, 2015; Egilson, 2014; Fournier et al., 2010; Jones, et al, 2011; Hoy et al, 2011; Overvelde & Hulstijin, 2011). Motor skill requires learning and extensive practice (Adolph & Berger, 2006) – opportunities impacted by the presence of physical disability (Egilson & Traustadottir, 2009a) and the lack of motor development knowledge and training of teachers (Effgen & Chan, 2010; Ott & Effgen, 2000), who tend to reduce movement requirements to ensure safety or inclusion, which also reduces opportunities to learn (Forsyth & Basu, 2014; Gibson et al, 2009; Missiuna & Pollock, 1991). The current investigation has drawn upon occupational therapy expertise to build an instrument to support teachers' judgement-based assessment of motor performance needs. Further support for teachers to attend to motor learning needs in the classroom and facilitate expansion of opportunities for students to learn to move requires additional collaborative work, to determine intervention strategies at each level in each of the five dimensions for teachers to use and implement in their classrooms. Beyond this, more considered input into pre-service and in-service teacher training to support classroom facilitation of motor skill is suggested, as well as possible consideration of this area as a General Capability, using the underpinning learning progression of this research as a starting point for curriculum development.

An additional reflection regarding the influence of curriculum on interaction with students is its impact on occupational therapy assessment design. In the United States, the source of greatest influence on school-based occupational therapy practice due to its size

(AOTA, 2010), generic skill areas supporting effective school functioning are not part of the curriculum – essential for all to learn but are regarded as non-academic areas that may involve therapeutic intervention for some. Consequently, such aspects as social, organisational, and handwriting skills do not contain developmental descriptions of learning progress. The Australian Curriculum, by contrast, regards school functioning aspects such as interpersonal learning and personal and social capability as foundational curricular learning areas and supports teachers with curriculum resources to advance students progressively similarly to traditional learning domains (ACARA, 2014; MCEETYA, 2008). This assists teachers to view student difficulties in these areas as learning needs rather than fixed functioning deficits. However, goal-directed movement ability has not been included in this extended set, consequently, its status as “a discrete set of knowledge and skills that can be explored, broadened and deepened” (Howes, 2012, p.7) has not been adequately considered. This investigation has suggested a way to rectify this, using the five-dimensional learning progression as a basis from which to derive a set of curriculum standards. Divisions placed along its length through the process of standard-setting are consistent with Victorian Curriculum practice that focuses on levels of *learning* rather than *year* levels (Howes, 2012), enabling personalised instructional approaches unhampered by norm-referenced concerns.

In relation to the use of teachers as assessors, through the process of achieving a calibrated scale, this investigation has demonstrated the capacity of regular classroom teachers, when provided with objective criteria, to identify student motor ability (see Woods & Griffin, 2013 for a description of teachers’ similar capacity to identify literacy learning for students with disability). As teacher knowledge of students is high, and the time they spend with them extensive, teachers make an obvious assessor choice. However, while the research had noted the usefulness of judgement-based teacher-report questionnaires to shortening otherwise lengthy and expensive assessment processes involving health professionals (Blank,

Smits-Engelsman, Polatajko, & Wilson, 2012; Rosenblum, 2008), concerns had also been expressed about the ability of non-specialists to judge motor skill (Daniel & Froude, 1998; Faught et al, 2008; Junaid, Harris, Fulmer, & Carswell, 2000; Hammerschmidt & Sudsawad, 2004; Larkin & Rose, 2005; Stefansson & Karlsdottir, 2003; Sudsawad et al., 2001) and the need for training before using them as assessors has been recommended (Giofr , Cornoldi, & Schoemaker, 2014; Schoemaker et al., 2012). While further work establishing assessor inter- and intra-rater reliability is a future recommendation, this study has indicated that teacher judgement is aided by “adequate tools” in the form of descriptive, or fully criterion-referenced rating scales for each of the skills being assessed, and that the process of completing such assessments serves an educative purpose, supporting better understanding of motor skill acquisition (Forster & Masters, 2004, p.69; see also Clauser, 2000).

Study Limitations and Recommendations for Future Research

Limitations of the research pertain to characteristics of the data sample and unexplored aspects of validity and reliability. While these limitations are not deemed to have affected the research findings, they suggest possible areas for future research.

Limitations of the Research

Data sample considerations. While the total number of student participants in the main study (n=650) was sufficiently large for the conclusions drawn about the instrument, the number from mainstream schools was small (n=23), with only three students of that group being of secondary school age (13-18 years). One potential implication of this is that minimal data was collected about older students with more mild forms of motor learning need, since students with more severe forms of impairment, statistically, attend specialist settings. However, while this suggests value in further testing of the materials in mainstream and secondary school settings, it is also noted that representatively, students with severe motor impairments are more predominant than other impairment subgroups in mainstream

settings (ABS, 2015; see also Appendix A; Doubt & McColl, 2003), and that a full range of motor difficulties were found amongst the tested cohort. For example, as noted in Chapter Five, of the 675 students with ASD assessed in the trial, 633 did not have physical disability diagnoses, and amongst them, mild physical difficulties were frequently noted.

Validity and reliability considerations. Secondly, the focus of validity considerations has been on issues of construct validity. Greater exploration of this aspect of measurement design could fruitfully examine other validity aspects, for example, consequential validity and teachers' capacity to use the materials and the reports in the format/s recommended. As the second study gathered opinions from expert occupational therapists about report formats useful to different stakeholder groups, and there were differing opinions amongst this small group, trialling the different recommended formats with teachers, and gathering their perspectives, would be a valuable follow-up study.

In relation to tests of reliability, focus has been on item internal consistency – the reliability of the items to test and elicit performance of a unidimensional skill set and has not extended to other indications of reliability. This also suggests fruitful avenues for further research, particularly, establishing inter- and intra-rater reliability. An indication of inter-rater reliability would involve comparing the responses of two teachers on the same child and their level of agreement, to evaluate the extent of error and compromised reliability of results arising from variations in scorer stringency. An indication of test-retest, temporal, or intra-rater reliability would involve testing the same child at two different times to determine the stability of scores over time. This could be conducted in the context of a study involving planning and delivering intervention programs, then retesting, which would also potentially inform about learning capacities in relation to different impairments/ severities and establish the usefulness of the assessment as an intervention outcome measure.

Recommendations for Future Research

Indications for future research have been suggested in previous sections, including calibrating additional skills to fill gaps in the learning continua of Balance (Dimension 1) and Communication (Dimension 4) and determining whether different practice opportunities relate to differences in performance by students with the same kinds and severities of motor impairment. Additionally, the scale's usefulness could be expanded by providing best-practice teaching suggestions appropriate to each dimension and learning stage, supporting intervention planning and differentiated instruction. A follow-up study with classroom teachers and learning intervention teams could be undertaken to determine the standards-referenced scale's capability to guide classroom intervention. This could include a repeat assessment of students involved in the targeted intervention to indicate outcomes of this learning, establishing the contribution of classroom intervention to improved performance.

Final Conclusions

Bernstein saw opportunities to learn motor skill “like gold specks scattered all around the world of our everyday movements, just like those in the gold-bearing sand of the river bed” (Bernstein, 1996, p.213). In keeping with this, the contention of this research is that ordinary classrooms are motor learning domains of importance for all students, and particularly so for those needing extra opportunities to learn to move well. The major outcome of the two studies conducted in response to the research questions of this thesis has been a learning progression supporting formative assessment of goal-directed movement in everyday classrooms, where movements of many kinds are called for, and progress can advance incrementally over years.

From the perspective of education, classroom-related movement had not been explicated as a learning domain, hence teachers were not well supported to address motor learning needs systematically as they did for other curriculum areas. The development of this judgement-

based observational questionnaire has provided a means to rectify this, establishing empirically a set of indicative skills in goal-directed movement, and five underpinning dimensions identified through the research literature, and, for the first time, has expressed these as a developmental learning continuum enabling formative assessment by teachers.

From the perspective of school-based occupational therapy, judgement-based motor skill assessments for proxy teacher administration had not been designed to identify learning readiness in support of teachers, nor were they fully supporting students in the occupational 'learner' role. Instead, their focus remained on deficit identification and typical benchmarks, particularly in their rating scales. The development of this judgement-based observational questionnaire has provided additional input for intervention decision-making in the form of a fully criterion-referenced and positive description of movement at every level across the learning continuum, supporting efforts to systematically advance students. Hence, by drawing on the expertise of both professions, oversights in both have been addressed, and support for student learning in a domain of lifelong importance strengthened.

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Appendix A. School-aged Children with Disabilities, Australia

ABS (2009, 2015)*			NCCD (2016)*		
Disability definition	-	any limitation, restriction or impairment which restricts everyday activities and has lasted, or is likely to last, for at least 6 months	-	loss of bodily or mental functions, loss of part of the body, disease or illness, disfigurement	
	-	physical impairment incl. shortness of breath, blackouts, seizures, chronic/ recurrent pain that restricts activity, incomplete use of arms or fingers, difficulty gripping or holding things, incomplete use of feet or legs, restriction in physical activity, and disfigurement/ deformity.	-	disorders affecting learning, thought processes, perception of reality, emotions or judgement, or that disturb behaviour	
	-	based on the International Classification of Functioning, Disability and Health (ICF, 2001) which approaches disability functionally, i.e., by its impact rather than cause	-	disabling conditions that previously existed, or may exist in the future	
			-	disorders imputed to a person, who may not have a disability but who experiences discrimination by association, or is treated as impaired, due to, for example, obesity or physical sensitivities	
			-	any of the above conditions that require schooling adjustment of any kind or level	
			-	based on the Australian Disability Discrimination Act (1992)	
Prevalence (in 3,800,000 total school attenders)			18% (1 in 6; 685,911)		
By gender	Boys	Girls	Not provided		
	62% (185,000, 1 in 10)	38% (115,000, 1 in 16)			
Categories are by disability type (if multiple disabilities, counted multiple times)	Intellectual	59.5%, 174,000	Categories are by primary reason support was provided (those with multiple disabilities counted once by category which was the main support cause)	Cognitive**	55%, 377,250
	Head injury, brain damage	4.8%, 14,200		Social/ emotional**	24%, 164,620
	Psychological	17.5%, 51,100		Physical**	16%, 110,150
	Physical	30.3%, 88,800			
	Sensory/ speech	34%, 99,600			
	Other	21%, 61,400			

Severity is reported by support required	All		Physical	All
	School-related needs special assistance and/or equipment to participate in school	16.9%, 49,400	Quality differentiated teaching practice (QDTP) , same curriculum, monitoring and targeted teaching	64%, 70,246
	Mild – needs no help, no difficulty with core activities, uses aids and equipment	21%, 61,600	Supplementary adjustment , same curriculum with some modification, technology, intermittent support	27%, 30,084
	Moderate – needs no help, but has difficulty with core activities	22.9%, 66,900	Substantial adjustment – different curriculum, individualised instruction and adjustment	6%, 6,600
	Severe – sometimes needs help with core activities	27.5%, 80,500	Extensive adjustment – individual learning plan, specific measures and resourcing required always	3%, 3,300
	Profound – always needs help with core tasks			8%, 55,000
Core areas impacted	Mobility	Self-care	Communication	<i>Not provided</i>
	57.8%, 170,500	29.5%, 87,000	41.4% 121,000	
By number of disabilities	17% with physical disability also have ID 34% with physical disability also have learning difficulties Almost 50% with ID also have physical disability <i>Not provided – only one (primary) category per child is reported</i>			
By school type		Mobility	Physical	All
	Mainstream	55.6%	70%	65.9%
	Special class	28.7%	17.3%	24.3%
	Sp. school***	15.6%	12.7%	9.9%
By support type		Mobility	Physical	All
	Sp. equip't	10.8%	13.6%	7.1%
	Sp. tuition	47.3%	35%	39.4%
	Sp. assess't	20.7%	16.4%	15.2%
<i>Not provided in this way – examples only to assist teachers***</i>				

	Support person	28.5%	23.7%	21.9%
	Sp. transport	8.6%	10.2%	7.2%
Reported difficulties	61% (183,500) of all students with disabilities report difficulties in learning; 50.6% with physical disabilities			Not provided – data is teacher report of support provided, not student report of difficulties experienced

Notes:

- * *The figures are difficult to interpret together, as the ABS category is more discrete in its exclusion of imputed categories, past and future disability experiences, and associates of the student; hence the disparity between the 88,800 students with physical disability in the ABS and the NCCD 110,150 figure. These latter are not all those with physical difficulties at school, but only those whose primary need for adjustment was physical. Neither can the ABS 170,500 students with mobility limitations be aligned to the NCCD 110,150 figure, as the former figure refers to a broad group whose difficulties include mobility, but not necessarily as the most debilitating cause, whereas the latter group refers to those who have physical issues as their reason for adjustment/support in the classroom. Finally, specific motor disorders (such as DCD), while numerically significant and functionally impacting are not funded and often go undiagnosed, so may be appearing here only in the minimal support category of the NCCD.*
- ** *This is not the number/ proportion with these difficulties, but the number whose educational adjustment or support was for these reasons.*
- *** *Receive significantly more support – in mainstream schools, supported students attract a disability loading of 186% of the base per student amount; in special settings, this is 223% (Education and Employment References Committee, 2016).*

Appendix B. Instruments Excluded from the Review

While the following assessments/ questionnaires have been, or could be used by teachers, they were excluded from the review for the following reasons:

- *Developmental Coordination Disorder Questionnaire (DCDQ)* (Wilson, Kaplan, Crawford, Campbell, & Dewey, 2000) – excluded because it is primarily a child self-report and parent-administered assessment with no separate teacher tool. In addition, the skills assessed are predominantly not classroom-related.
- *Dynamic Performance Analysis (DPA)* (Polatajko, Mandich, & Martini, 2000) – excluded because it is a performance-based assessment that is administered by therapists.
- *Draw a Person Screening Questionnaire (DPSC)* (Shooman & Rosenblum, 2014) – excluded because it is a performance-based assessment, and its narrow age-range targets mainly pre-school-aged children and activities and tasks in non-classroom settings.
- *Goal Attainment Scaling (GAS)* (Kiresuk & Sherman, 1968) – excluded because it is an individualised goal-setting and treatment evaluation tool, rather than an assessment.
- *Miller Function and Participation Scales (M-FUN)* (Miller, 2006) – excluded because it is principally a performance assessment for therapist-administration and the additional parent/teacher questionnaires contain minimal motor skill items.
- *Perceived Efficacy and Goal-setting Scale (PEGS)* (Missiuna, Pollock, & Law, 2004) – excluded because it is principally a child self-report tool for goal-selection, with minimal motor skill items.
- *Teachers Rating Scale of the Child's Actual Behaviour (TRS)* (Harter, 1985) – excluded due to minimal motor skill items and non-classroom focus.

In summary, the following table lists the reasons for exclusion:

Reasons for exclusion:	DCDQ	DPA	DPSQ	GAS	M-FUN	PEGS	TRS
Not an assessment				✓			
Not principally for proxy teacher administration	✓	✓		✓	✓	✓	
Not principally judgement-based		✓	✓		✓		
Not principally about motor skills					✓	✓	✓
Not principally about classroom tasks			✓		✓		✓
Not principally for school-aged children			✓				

Appendix C. Study 1: Recruitment and Permission Documents

C1: Principal/Teacher/Parent Plain Language Statements



Using developmental assessment to support movement and motor skills learning for students with additional needs

We invite you and your teachers to participate in research being conducted as a doctoral study by Mrs Lindsey Gale under the supervision of Dr Kerry Woods and Associate Professor Shelley Gillis of the Assessment Research Centre, Melbourne Graduate School of Education, the University of Melbourne. The research is funded by an Australian Research Council Linkage grant, with the support of the Victorian Department of Education and Training's Wellbeing, Health and Engagement Division.

What are the aims of the research?

The research aims to design and validate assessment and planning materials to support the professional practice of teachers of students with additional learning needs. It will investigate ways to guide teachers' observations of their students' learning and report students' observed skills against developmental progressions, which will then be validated in terms of their usefulness for teachers' planning and implementation of individual learning programs.

The focus of the research is the assessment and teaching of movement and motor skills.

The work builds on an established body of research into assessment and teaching of a sub-set of these skills, which resulted in resources currently used in Victorian government schools as the Abilities Based Learning and Education Support (ABLES) program and in schools outside the government system as the Students with Additional Needs (SWANs) program.

What will your teachers be asked to do?

Should you agree to participate, an invitation will be extended to teachers at your school to participate in the research and their voluntary consent will be sought

Your teachers will be asked to trial assessment materials delivered via an online program (i.e., the ABLES or SWANs online assessment and reporting program).

Each assessment is expected to take approximately ten minutes to complete, on average, and teachers will be asked to complete assessments for between one and four of their students. They may be asked to use the assessment materials at two points in time within one school year. The incidental observations teachers have access to in their daily classroom interactions with students will be sufficient to inform assessments. Students will not participate directly in the project nor will they undertake any assessment or activity that is outside their normal classroom routine.

In a second component of the research, your teachers may be invited to discuss and monitor the impact of the individual learning plans (ILPs) they develop for their students after using the assessment and reporting materials. Their participation in this aspect of the research will involve two 30 minute interviews to first discuss their planning decisions and then, at a later point in time the impact of their implemented program on student learning. This will be cross-referenced to information on student learning gathered via teachers' use of the assessment materials.

Some teachers may also be invited to participate in a one-hour focus group discussion to gather information on their perceptions of the usefulness and impact of the assessment, reporting, planning, and teaching materials for their professional practice. These discussions will not be audio- or video-taped.

Your decision regarding participation in the research will not, in any way, affect your employment opportunities or those of your teachers, or the current educational experiences of the students at your school.

HREC: Project No 1543899.1; Date: 23/07/15; Version: Principal

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How will confidentiality be protected?

Participation in this study is completely voluntary, and anonymity and confidentiality of students' assessment data and teachers' responses to interview and focus group questions will be ensured to the fullest possible extent. The research team will not have access to the identity or identifying codes of the students reported on. Only teachers will know which students were chosen for the study. The researchers subsequently handling the data will not have access to any identifying information about students.

Teachers who participate in the research will be potentially identifiable, to allow the researchers to interview them at two points in time across a school year. For data management and analysis, however, their identifying details will be removed and replaced with a code.

Schools and participants will not be named in any report arising from this research. The information we obtain will be included only as a summary in reports of the study. Should you wish to withdraw from the study at any time, or to withdraw unprocessed information that has been collected, you are completely free to do so. All information will be treated in the strictest confidence subject to any legal limitations. It will be stored in secured files at the University of Melbourne under the University's guidelines for the management of research data and records, and destroyed five years after publication of written findings.

How will you receive feedback?

On completion of the research, a summary of findings will be made available to you. It is expected that the results will be disseminated through research journals and presented at educational conferences.

How do you agree to participate?

If you would like to participate, please indicate that you have read and understood this information by signing the accompanying consent form and returning it to Dr Kerry Woods in the enclosed envelope or in scanned format to the email address that follows. Should you require any further information or have any concerns, please do not hesitate to contact Dr Kerry Woods on 8344 9535 (k.woods@unimelb.edu.au). This research is conducted with the clearance of the Human Research Ethics Committee (HREC), University of Melbourne. If you have any concerns regarding the conduct of the research, which you do not wish to discuss with the research team, you are welcome to contact the Manager, Human Research Ethics, University of Melbourne, VIC 3010. Tel: (03) 8344 2073).

Thank you for giving some of your time to reading this statement and considering its contents.

Yours sincerely,

Dr Kerry Woods
Melbourne Graduate School of Education
The University of Melbourne

Mrs Lindsey Gale
Melbourne Graduate School of Education
The University of Melbourne

Associate Professor Shelley Gillis
Melbourne Graduate School of Education
The University of Melbourne

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Using developmental assessment to support movement and motor skills learning for students with additional needs

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What are the aims of the research?

The research aims to design and validate assessment and planning materials to support the professional practice of teachers of students with additional learning needs. It will investigate ways to guide teachers' observations of their students' learning and report students' observed skills against developmental progressions, which will then be validated in terms of their usefulness for teachers' planning and implementation of individual learning programs.

The focus of the research is assessment and teaching of foundational movement and motor skills.

The work builds on an established body of research into assessment and teaching of a sub-set of these skills, which resulted in resources currently used in Victorian government schools as the Abilities Based Learning and Education Support (ABLES) program and in schools outside the government system as the Students with Additional Needs (SWANs) program.

What will you be asked to do?

Should you agree to participate, you will be asked to trial assessment materials delivered via an online program (i.e., the ABLES or SWANs online assessment and reporting program).

Each assessment is expected to take approximately ten minutes to complete, on average, and you will be asked to complete assessments for between one and four of your students. You may be asked to use the assessment materials at two points in time within one school year. The incidental observations you have access to in your daily classroom interactions with students will be sufficient to inform assessments. Students will not participate directly in the project nor will they undertake any assessment or activity that is outside their normal classroom routine.

In a second component of the research, you may be invited to discuss and monitor the impact of the individual learning plans (ILPs) you develop for your students after using the assessment and reporting materials. Your participation in this aspect of the research will involve two 30 minute interviews to first discuss your planning decisions and then, at a later point in time, the impact of your implemented program on student learning. This will be cross-referenced to information on student learning gathered via use of the assessment materials.

You may also be invited to participate in a one-hour focus group discussion to gather information on your perceptions of the usefulness and impact of the assessment, reporting, planning, and teaching materials for your professional practice. This will not be audio- or video-taped.

Your decision regarding participation in the research will not, in any way, affect your employment opportunities or the current educational experiences of your students.

HREC: Project No 1543899.1; **Date:** 13/07/15; **Version:** Teacher

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How will confidentiality be protected?

Participation in this study is completely voluntary, and anonymity and confidentiality of students' assessment data and your responses to interview and focus group questions will be ensured to the fullest possible extent. The research team will not have access to the identity or identifying codes of the students reported on. Only teachers will know which students were chosen for the study. The researchers subsequently handling the data will not have access to any identifying information about students.

Teachers who participate in the research will be potentially identifiable, to allow the researchers to interview you at two points in time across a school year. For data management and analysis, however, your identifying details will be removed and replaced with a code.

Schools and participants will not be named in any report arising from this research. The information we obtain will be included only as a summary in reports of the study. Should you wish to withdraw from the study at any time, or to withdraw unprocessed information that has been collected, you are completely free to do so. All information will be treated in the strictest confidence subject to any legal limitations. It will be stored in secured files at the University of Melbourne under the University's guidelines for the management of research data and records, and destroyed five years after publication of written findings.

How will you receive feedback?

On completion of the research, a summary of findings will be made available to your school principal. It is expected that the results will be disseminated through research journals and presented at educational conferences.

How do you agree to participate?

If you would like to participate, please indicate that you have read and understood this information by signing the accompanying consent form and returning it to Dr Kerry Woods in the enclosed envelope or in scanned format to the email address that follows. Should you require any further information or have any concerns, please do not hesitate to contact Dr Kerry Woods on 8344 9535 (k.woods@unimelb.edu.au). This research is conducted with the clearance of the Human Research Ethics Committee (HREC), University of Melbourne. If you have any concerns regarding the conduct of the research, which you do not wish to discuss with the research team, you are welcome to contact the Manager, Human Research Ethics, University of Melbourne, VIC 3010. Tel: (03) 8344 2073).

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Using developmental assessment to support movement and motor skills learning for students with additional needs

Your child's teacher has been invited to participate in research being conducted as a doctoral study by Mrs Lindsey Gale under the supervision of Dr Kerry Woods and Associate Professor Shelley Gillis of the Assessment Research Centre, Melbourne Graduate School of Education at the University of Melbourne. The research is funded by an Australian Research Council Linkage grant, with the support of the Victorian Department of Education and Training's Wellbeing, Health and Engagement Division.

What are the aims of the research?

This research aims to create assessment and planning materials for teachers, to help them support their students' learning of movement skills. As a consequence it is hoped that the learning outcomes of students will be enhanced.

What is your child's involvement in the research?

Your child will not participate directly in the research. Your child's teacher will fill out an online assessment about your child's skills in one or more learning area. The everyday knowledge the teacher has about your child is all that will be needed to complete an assessment. Your child's teacher may also talk to one of our research team about the planning decisions they have taken to support your child's learning.

The education of your child will not be altered in any way by you agreeing for him or her to be part of this research. Your child will not be asked to do anything differently or to take part in any activities that are not part of the normal classroom routine. No information about your child's identity will be supplied to us. At the end of the study, you will be provided with copies of your child's reports on request.

How will confidentiality be protected?

Your child's participation in this study is completely voluntary. Should you wish to withdraw your child from the study at any stage, or to withdraw any of your child's assessment information that has not been analysed, you are completely free to do so. We will protect your child's anonymity and privacy to the fullest possible extent. Confidentiality will be protected because any information that could identify your child will not be supplied to us. The information gathered during the study will be stored in secured files at the University of Melbourne, under the University's guidelines for the management of research data and records, and destroyed five years after publication of written findings.

How do you agree to let your child participate?

If you agree for your child's teacher to take part in the study, please indicate that you have read and understood this information by signing the accompanying consent form and returning it your child's school. After this is signed, you may still withdraw your child from the research at any time.

HREC: Project No 1543899.1; **Date:** 23/07/15; **Version:** Parent/Guardian

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How do you obtain further information?

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C2: Principal/Teacher/Parent Consent Forms

**Using developmental assessment to support movement and motor skills learning for students
with additional needs**

Name of Principal:

Name of School:

Name of Investigators: Dr Kerry Woods, Associate Professor Shelley Gillis, Mrs Lindsey Gale

I consent to the participation of my school and teachers in the above research. I understand the nature of the research and what is expected of my school and teachers, and I agree to the participation of my school on that basis.

I acknowledge that:

- I have received a copy of and read the Plain Language Statement explaining the study;
- I have received an adequate explanation of all likely risks, effects, discomforts or inconvenience arising from participation in the project;
- I understand participation is voluntary, that I and my teachers have the right to withdraw at any time, and that we may withdraw any data supplied up to the point of analysis and publication;
- I understand that I and my teachers will not be video-taped, audio-taped, or photographed;
- I have been informed that the confidentiality of the information I and my teachers provide will be safeguarded, subject to any legal requirements (e.g., subpoena, freedom of information, mandated reporting), and in the following ways:
 - no names or personal details of individual participants will be revealed in any report of the study, and any contextual details that might reveal their identity will be removed;
 - only the investigators will have access to the data collected in this study; and
 - data will be stored securely in a locked facility in the Assessment Research Centre, Melbourne Graduate School of Education, and destroyed five years after the completion of the written findings of the research.

Principal's Signature:.....

Date:

HREC: Project No 1543899.1; **Date:** 23/07/15; **Version:** Consent Form for Principal

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Using developmental assessment to support movement and motor skills learning for students with additional needs

Name of Teacher:

Name of School:

Names of Investigators: Dr Kerry Woods, Associate Professor Shelley Gillis, Mrs Lindsey Gale

I consent to participate in the above research. I understand the nature of the research and what is expected of me, and I agree to take part on that basis.

I acknowledge that:

- I have received a copy of and read the Plain Language Statement explaining the study;
- I have received an adequate explanation of all likely risks, effects, discomforts or inconvenience arising from participation in the project;
- I understand my participation is voluntary, that I have the right to withdraw at any time, and that I may withdraw any data supplied up to the point of analysis and publication;
- I understand that I will not be video-taped, audio-taped, or photographed;
- I have been informed that the confidentiality of the information I provide will be safeguarded, subject to any legal requirements (e.g., subpoena, freedom of information, mandated reporting), and in the following ways:
 - no names or personal details of individual participants will be revealed in any report of the study, and any contextual details that might reveal their identity will be removed;
 - only the investigators will have access to the data collected in this study; and
 - data will be stored securely in a locked facility in the Assessment Research Centre, Melbourne Graduate School of Education, and destroyed five years after the completion of the written findings of the research.

Teacher

Date:

HREC: Project No 1543899.1; **Date:** 23/07/15; **Version:** Consent Form for Teacher

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Using developmental assessment to support movement and motor skills learning for students with additional needs

Name of Student:

Name of Parent/Guardian:

Name of School:

Name of Investigators: Dr Kerry Woods, Associate Professor Shelley Gillis, Mrs Lindsey Gale

I consent for my child's teacher to participate in the above research. I understand the nature of the research and what is expected of my child's teacher.

I acknowledge that:

- I have received a copy of and read the Plain Language Statement explaining the study;
- I have received an adequate explanation of all likely risks, effects, discomforts or inconvenience arising from participation in the project;
- I understand that participation in the study is voluntary, that I have the right to withdraw my consent for my child's teacher to participate in the study at any time, and that I may withdraw any data supplied up to the point of analysis and publication;
- I understand that my child and my child's teacher will not be video-taped, audio-taped, or photographed;
- I have been informed that the confidentiality of the information provide by my child's teacher will be safeguarded, subject to any legal requirements (e.g., subpoena, freedom of information, mandated reporting), and in the following ways:
 - no names or personal details of individual participants will be revealed in any report of the study, and any contextual details that might reveal their identity will be removed;
 - only the investigators will have access to the data collected in this study; and
 - data will be stored securely in a locked facility in the Assessment Research Centre, Melbourne Graduate School of Education, and destroyed five years after the completion of the written findings of the research.

Signature of Parent/Guardian:..... **Date:**

HREC: Project No 1543899.1; **Date:** 23/07/15; **Version:** Consent Form for Parent/Guardian

Assessment Research Centre, Melbourne Graduate School of Education

The University of Melbourne Victoria 3010 Australia

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Appendix D. Study 1: Ethics Approval Documentation

D1: Melbourne Graduate School of Education Approval

22 July 2015

Dr Kerry Woods
Melbourne Graduate School of Education
The University of Melbourne



Dear Dr Woods,

I am pleased to advise that the Melbourne Graduate School of Education Human Ethics Advisory Group (MGSE HEAG) has approved the following Project-within-Program application:

Project-within-Program

Project title: Using developmental assessment to support movement and motor skills learning for students with additional needs.
Researchers: Kerry Wood, Lindsey Gale and Shelley Gillis.
Ethics ID/HREC: 1543899
MGSE HEAG ID: 118/15

Related Program

Program title: The design and validation of assessment, reporting, and planning materials to support foundational skill development for children and young people with additional learning needs.
Ethics ID: 1443300

The project has been approved for the period: 22 July 2015 to 31 December 2015.

It is your responsibility to ensure that all people associated with the Project-within-Program are made aware of what has actually been approved.

A Project-within-Program is normally approved to 31 December of the year of approval and may be renewed yearly for up to a total of three years upon receipt of a satisfactory annual report. If a Project-within-Program is to continue beyond three years a new application will normally need to be submitted.

Please note that the following conditions apply to your approval. Failure to abide by these conditions may result in suspension or discontinuation of approval and/or disciplinary action.

- (a) **Limit of Approval:** Approval is limited strictly to the research as submitted in your Project application.
- (b) **Amendments to Project:** Any subsequent variations or modifications you might wish to make to the Project must be notified formally to the Human Ethics Advisory Group for further consideration and approval before the revised Project can commence. If the Human Ethics Advisory Group considers that the proposed amendments are significant, you may be required to submit a new application for approval of the revised Project.
- (c) **Incidents or adverse affects:** Researchers must report immediately to the Advisory Group and the relevant Sub-Committee anything which might affect the ethical acceptance of the protocol including adverse effects on participants or unforeseen events that might affect continued ethical acceptability of the Project. Failure to do so may result in suspension or cancellation of approval.
- (d) **Monitoring:** All projects are subject to monitoring at any time by the Human Research Ethics Committee.
- (e) **Annual Report:** Please be aware that the Human Research Ethics Committee requires that researchers submit an annual report on each of their projects at the end of the year, or at the conclusion of a project if it continues for less than this time. Failure to submit an annual report will mean that ethics approval will lapse.
- (f) **Auditing:** All projects may be subject to audit by members of the Sub-Committee.

Please quote the ethics registration number and the name of the Project in any future correspondence.

On behalf of the Ethics Committee I wish you well in your research.

Yours sincerely

Associate Professor Dianne Vella-Brodrick
Chairperson, Melbourne Graduate School of Education Human Ethics Advisory Group
Phone: 83440254, Email: dianne.vella-brodrick@unimelb.edu.au

cc: Lindsey Gale, Shelley Gillis and Human Research Ethics Committee (HREC), The Office for Research Ethics and Integrity.

Melbourne Education Research Institute (MERI)

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D2: Victorian Department of Education and Training Approval

Department of
Education & Training

Strategy & Review Group

2 Treasury Place
East Melbourne, Victoria 3002
Telephone: +61 3 9637 2000
DX 210083
GPO Box 4367
Melbourne, Victoria 3001

2015_002671

Dr Kerry Woods
Assessment Research Centre
Melbourne Graduate School of Education
The University of Melbourne
PARKVILLE 3010

Dear Dr Woods

Thank you for your application of 1 April 2015 in which you request permission to conduct research in Victorian government schools and/or early childhood settings *The design and validation of assessment, reporting and planning tools to support teachers' capacity to monitor and teach foundational learning skills for students with additional learning needs*.

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. The research is conducted in accordance with the final documentation you provided to the Department of Education and Training.
2. Separate approval for the research needs to be sought from school principals and/or centre directors. This is to be supported by the Department of Education and Training approved documentation and, if applicable, the letter of approval from a relevant and formally constituted Human Research Ethics Committee.
3. The project is commenced within 12 months of this approval letter and any extensions or variations to your study, including those requested by an ethics committee must be submitted to the Department of Education and Training for its consideration before you proceed.
4. As a matter of courtesy, you advise the relevant Regional Director of the schools or governing body of the early childhood settings that you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director or governing body.
5. You acknowledge the support of the Department of Education Training in any publications arising from the research.

6. The Research Agreement conditions, which include the reporting requirements at the conclusion of your study, are upheld. A reminder will be sent for reports not submitted by the study's indicative completion date.
7. If the Department of Education Training has commissioned you to undertake this research, the responsible Branch/Division will need to approve any material you provide for publication on the Department's Research and Evaluation Register.

I wish you well with your research study. Should you have further enquiries on this matter, please contact Youla Michaels, Project Support Officer, Insights and Evidence Branch, by telephone on (03) 9637 2707 or by email at michaels.youla.y@edumail.vic.gov.au.

Yours sincerely



Susan Thomas
Director
Insights and Evidence Branch

14/04/2015

Appendix E. Study 1 (Trial): Items and Demographic Questions

INSTRUCTIONS: For each question, please choose **ONLY ONE** response. The response you choose should be the closest match to this student's typical performance. If you feel the student performance falls between two levels, select the lower one. This will indicate that the student has achieved that level but has not reached the higher one.

Movement - using the capacities of the body to achieve one's goals

Q1. Maintains balance and upright posture

- ☐ Reacts to lost balance (e.g., rights head, extends arms)
- ☐ Explores limits of balance (e.g., rocks to point of tipping, moves head in different planes or directions)
- ☐ Focuses to maintain stable posture (e.g., attends to strategy, such as "feet flat, bottom back to sit up straight")
- ☐ Maintains balance and stability even when attention is directed elsewhere (e.g., talks while walking, climbs stairs safely in a crowd)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q2. Regulates physical tension

- ☐ Reacts to stimulation or emotion (e.g., changes level of engagement, changes breathing rate)
- ☐ Uses a strategy to manage physical tension during activity (e.g., requests a break, or calms by linking breathing to a slow, repetitive movement)
- ☐ Regulates physical tension and response during activities with changing energy demands (e.g., calms for quiet activity, following activity with raised energy)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q3. Coordinates response to sensory input

- ☐ Attends to the sensory aspects of objects or environment (such as sight, touch, sound, movement through space, or position in relation to gravity)
- ☐ Focuses on the sensation of moving to achieve routine movement tasks (e.g., watches hands to achieve accurate reach; attends to the feel of feet while walking)
- ☐ Practices moving under different sensory conditions (e.g. in time to a rhythm, in reduced light, at different speeds, or across different surfaces)
- ☐ Manages performance involving more than one demand (e.g., talks while navigating obstacles, or adjusts focus between working on own and with a partner)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q4. Positions self to engage in activity

- ☐ Responds to activity when positioned in front of it (e.g., shows interest, attempts to reach)
- ☐ Assists in being positioned for activity engagement (e.g., leans/ moves in)
- ☐ Positions self to commence activity (e.g., moves into position to enable use of objects/ tools)
- ☐ Anticipates and adjusts position throughout activity to support efficient functioning
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q5. Remembers a movement sequence

- ☐ Cooperates with the next step of a routine movement (e.g. turns towards, lifts arms)
- ☐ Repeats a simple movement sequence in imitation or from memory (e.g., copies a hand/arm movement; completes a sequence to sit up straight, start work, or walk in walker once assisted into it)
- ☐ Adapts a movement sequence to suit new circumstances (e.g., adapts movement for a different ground surface, changes strategy to reach accurately at different speeds)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q6. Moves from one position or place to another

- ☐ Shows awareness of being re-positioned or moved (e.g., orients or turns toward direction of travel, or reaches to touch surfaces/objects while passing)
- ☐ Focuses to move or reposition self in routine tasks (e.g., attends to placement of hands or feet, or next step of task)
- ☐ Practices moving and repositioning to improve speed and energy efficiency (e.g., combines aspects of movement to conserve energy, suggests or indicates alternative ways to be assisted)
- ☐ Combines moving or repositioning with other activities (e.g., transports objects while moving)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q7. Uses movement skills to avoid obstacles or prevent problems occurring

- ☐ Reacts when moved around obstacles and through narrow spaces (e.g., holds on, leans in)
- ☐ Attempts to avoid obstacles in familiar settings (e.g., gives wide berth, or stops to wait for another to pass)
- ☐ Modifies movement to avoid obstacles that have proved difficult in the past, or that have suddenly arisen (e.g., slows or focuses attention to avoid a trip hazard)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q8. Uses sporting or activity equipment (e.g., mats, balls, bikes, climbing equipment)

- ☐ Attends to properties or functions of equipment (e.g., touches, manipulates, shakes)
- ☐ Follows instructions to use equipment (e.g., holds kickboard as directed, practices two-handed throw)
- ☐ Adjusts and changes movement response to engage with equipment and requirements of activity (e.g., starts, stops or turns on whistle, moves faster to reach ball)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q9. Transports objects from place to place

- ☐ Cooperates in tasks involving transport of routine items
- ☐ Concentrates to achieve transport of self and object(s)
- ☐ Transports objects even while engaged on other aspects of activity (e.g., while manipulating objects, talking, or in crowded situations)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q10. Manages personal school equipment

- ☐ Attends to equipment when placed in hand or nearby (e.g. stills body, holds briefly)
- ☐ Achieves a component of equipment handling (e.g., holds backpack while another closes it)
- ☐ Exploits possibilities of body and environment for managing equipment independently (e.g., practices using different body parts to stabilise objects, or different ways to grip and operate backpack zip)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q11. Manipulates and uses tools and materials (such as writing and drawing implements, scissors, ruler, keyboard, mouse/switch)

- ☐ Responds to sensory properties of tools and materials (e.g. tightens and loosens grip, moves fingers over surface)
- ☐ Focuses or slows to use tools and materials with appropriate strength and control (e.g. concentrates to operate mouse or keyboard, or to hold pen/ pencil lightly and press gently when writing)
- ☐ Manipulates and uses tools and materials with appropriate strength and control, while attending to other aspects of task (e.g., releases object accurately while attending to next step of task, or stabilises paper while writing)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q12. Shares space interactively with others

- ☐ Reacts or attends when others come close
- ☐ Manages own needs in shared space (e.g., follows instructions for avoiding bumping into others, experiments with how much room is needed to pass by another safely)
- ☐ Cooperates with others to share the space (e.g., moves responsively, or moves over to share desk space)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q13. Uses movement for self-expression and communication

- ☐ Uses gestures/ facial expressions interpretable to familiar others
- ☐ Uses a consistent repertoire of gestures/ facial expressions to establish meaning
- ☐ Expands and extends what can be communicated by the body
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q14. Perseveres in movement tasks or activities

- ☐ Participates in movement activities that are easily achieved, or provide immediate positive outcome (e.g., moves towards desired object or person)
- ☐ Completes tasks within movement capacity with prompting or support (e.g., takes items from backpack when instructed)
- ☐ Initiates an attempt at new or more difficult aspects of tasks (e.g., exerts self to complete task, or attempts task on own)
- ☐ Adapts movement strategies in response to more challenging settings (e.g., devises a new strategy for carrying objects over greater distances, or uses an alternative way to travel across a different ground surface)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q15. Works within physical limits

- ☐ Relies on direct instruction to regulate involvement (e.g., takes a break when directed)
- ☐ Adheres to rules regarding level of involvement and activity choice (e.g., checks with adult before engaging in new activity)
- ☐ With planning, achieves maximum involvement possible within physical limits (e.g., conserves energy by combining steps, or sits where possible to achieve tasks)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q16. Completes tasks involving strenuous movement

- ☐ Maintains energy output for duration of simple routine tasks (e.g., packing up, putting away and moving between activities)
- ☐ Engages in occasional strenuous movement during activity (e.g., during stretching exercises, or in moving to music)
- ☐ Manages a strenuous activity at slowed pace, or with rest periods
- ☐ Completes strenuous movement activities comfortably (e.g., at required speed, or while maintaining focus on other aspects of task)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Please select the option that best describes your experience

- Q1. How long have you been teaching?**
- ☐ Less than 6 months
 - ☐ 6 - 12 months
 - ☐ 1 - 3 years
 - ☐ 3 - 6 years
 - ☐ 6 - 10 years
 - ☐ Over 10 years
- Q2. What is your primary role at this school?**
- ☐ Classroom teacher
 - ☐ Special education coordinator
 - ☐ Specialist teacher of movement (e.g., physical education, swimming, dance)
 - ☐ Other (please specify)
- Q3. Have you previously taught, cared for or supported a child or young person with any of the following disabilities? (Mark all that apply)**
- ☐ Physical impairment
 - ☐ Intellectual impairment
 - ☐ Sensory impairment (affecting sight, hearing or speech)
 - ☐ Autism Spectrum Disorder
 - ☐ Attention Deficit Hyperactivity Disorder (ADHD), Learning Disability (LD), or other emotional or behavioural concern
 - ☐ Other (please specify)
- Q4. How long have you been working with this student?**
- ☐ Less than 3 months
 - ☐ 3 - 6 months
 - ☐ 6 - 12 months
 - ☐ 1 - 2 years
 - ☐ Over 2 years
- Q5. Does this student have a diagnosis of physical disability?**
- ☐ No
 - ☐ Yes
 - ☐ Don't know
- Q6. Does this student have a diagnosis of vision impairment?**
- ☐ No
 - ☐ Yes
 - ☐ Don't know
- Q7. Does this student have a diagnosis of severe behaviour disorder?**
- ☐ No
 - ☐ Yes
 - ☐ Don't know
- Q8. Does this student have a diagnosis of hearing impairment?**
- ☐ No
 - ☐ Yes
 - ☐ Don't know
- Q9. Does this student have a diagnosis of intellectual disability?**
- ☐ No
 - ☐ Yes
 - ☐ Don't know
- Q10. Does this student have a diagnosis of Autism Spectrum Disorder?**
- ☐ No
 - ☐ Yes
 - ☐ Don't know
- Q11. Does this student have a diagnosis of severe language disorder with critical educational needs?**
- ☐ No
 - ☐ Yes
 - ☐ Don't know
- Q12. Does this student have any other condition? (please specify)**
-
- Q13. Is there anything else you would like to tell us about this student's additional learning needs?**
-

Appendix F. Study 1 (Trial): Differential Weighting Judgement Matrix

 Harder steps	1.4 Maintains balance even when attention is directed elsewhere	2.3 Regulates response to changing energy demands	3.4 Manages performance involving more than one demand			6.4 Combines moving with other activities		
			3.3 Practices moving under different sensory conditions	4.4 Anticipates and adjusts position throughout activity	5.3 Adapts a movement sequence to suit new circumstances	6.3 Practices moving to improve speed and efficiency	7.3 Modifies movement to avoid obstacles of past difficulty	8.3 Adjusts movement to demands of equipment and activity
	1.3 Focuses to maintain stable posture	2.2 Uses a strategy to manage physical tension	3.2 Focuses on the sensation of moving	4.3 Positions self to commence activity				
	1.2 Explores limits of balance			4.2 Assists in being positioning for activity engagement	5.2 Repeats a simple movement sequence	6.2 Focuses to move in routine tasks		8.2 Follows instructions to use equipment
			3.1 Attends to sensory aspects		5.1 Cooperates with the next step of a <u>routine</u> movement		7.2 Attempts to avoid obstacles in <u>familiar</u> settings	
Easier steps	1.1 Reacts to lost balance	2.1 Reacts to stimulation or emotion		4.1 Responds to activity when positioned in front of it		6.1 Shows awareness of being moved	7.1 Reacts when moved around obstacles	8.1 Attends to equipment properties
ITEMS >	1 Maintains balance	2 Regulates physical tension	3 Coordinates response to sensory input	4 Positions self to engage in activity	5 Remembers a movement sequence	6 Moves from one position/ place to another	7 Avoids obstacles	8 Uses activity/ games equipment

Harder steps		10.3 Exploits possibilities for managing equipment independently	11.3 Handles tools appropriately while attention elsewhere		13.3 Expands and extends bodily communication possibilities	14.4 Adapts new strategies to more difficult settings	15.3 With planning, achieves maximum involvement possible	16.4 Completes strenuous activity comfortably
	9.3 Transports objects even while attention engaged elsewhere			12.3 Cooperates with others to share the space		14.3 Initiates an attempt at new or more difficult aspects		
			11.2 Focuses or slows to use tools and materials	12.2 Manages own needs in shared space	13.2 Uses a consistent repertoire of gestures			16.3 Manages strenuous activity slowly or with rests
	9.2 Concentrates to achieve transport of self and object(s)	10.2 Achieves a component of equipment handling				14.2 Completes tasks within capacity with prompting	15.2 Adheres to rules regarding level of involvement	16.2 Engages in occasional strenuous activity
	9.1 Cooperates in tasks involving transport of <u>routine</u> items				13.1 Uses gestures interpretable to familiar others	14.1 Participates for immediate positive outcome	15.1 Relies on direct instruction to regulate involvement	16.1 Maintains energy for simple tasks
Easier steps		10.1 Attends to equipment when placed in hand or nearby	11.1 Responds to sensory properties	12.1 Reacts when others come close				
ITEMS >	9 Transports objects	10 Manages school equipment	11 Uses and manipulates tools and materials	12 Shares space interactively with others	13 Uses movement to express self	14 Perseveres in movement tasks	15 Works within physical limits	16 Completes strenuous movement tasks

Appendix G. Study 1 (Main Study): Items and Demographic Questions

INSTRUCTIONS: For each question, please choose **ONLY ONE** response. The response you choose should be the closest match to this student's typical performance. If you feel the student performance falls between two levels, select the lower one. This will indicate that the student has achieved that level but has not reached the higher one.

Movement - using the capacities of the body to achieve one's goals

Q1. Maintaining balance and upright posture (seated or standing)

- ☐ Reacts to lost balance (e.g., startles; rights head; extends arms)
- ☐ Relies on strategies or cues to maintain stable posture (e.g., 'feet flat, bottom back to sit up straight')
- ☐ Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)
- ☐ Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q2. Regulating physical tension

- ☐ Reacts to stimulation or emotion (e.g., changes level of engagement; changes breathing rate)
- ☐ Uses a strategy to manage physical tension during activity (e.g., requests a break; calms by linking breathing to a slow, repetitive movement)
- ☐ Regulates physical tension and response during activities with changing energy demands (e.g., calms for quiet activity following activity with raised energy)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q3. Coordinating response to sensory input

- ☐ Attends to the sensory aspects of objects or environment (such as sight, touch, sound, movement through space, or position in relation to gravity)
- ☐ Focuses on the sensation of moving to achieve routine movement tasks (e.g., watches hands to achieve accurate reach; attends to the feel of feet while walking)
- ☐ Practices moving under different sensory conditions (e.g. in time to a rhythm; in reduced light; at different speeds; across different surfaces)
- ☐ Manages performance involving more than one demand (e.g., talks while navigating obstacles; adjusts focus between working on own and with a partner)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q4. Positioning self to engage in activity

- ☐ Responds to activity when positioned in front of it (e.g., shows interest; attempts to reach)
- ☐ Assists in being positioned for activity engagement (e.g., leans/ moves in)
- ☐ Positions self to commence activity (e.g., moves into position to enable use of objects/ tools)
- ☐ Anticipates and adjusts position throughout activity to support efficient functioning
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q5. Remembering a movement sequence or strategy

- ☐ Cooperates with the next step of a routine movement (e.g. turns towards; lifts arms)
- ☐ Repeats a simple movement sequence in imitation or from memory (e.g., to sit up straight; walk in walker; remove/put on jumper)
- ☐ Adapts a movement sequence to suit new circumstances (e.g., changes strategy to reach accurately at different speeds; alters gait quickly in response to suddenly changed conditions; combines sequences/strategies to achieve more of a task)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q6. Moving from one position or place to another (with or without mobility aid)

- ☐ Shows awareness of being re-positioned or moved (e.g., orients or turns toward direction of travel; reaches to touch surfaces/objects while passing)
- ☐ Focuses, or attends consciously, in order to reposition self during routine tasks (e.g., attends consciously to placement of feet; focuses achieve the movement requirements of the next step of task)
- ☐ Masters fluency and control when moving or repositioning quickly (e.g., changes direction smoothly in response to demands of a game; negotiates crowded hallways without difficulty; fluently achieves multi-step tasks)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q7. Using movement skills to avoid obstacles or prevent problems occurring

- ☐ Reacts when moved around obstacles and through narrow spaces (e.g., holds on; leans in)
- ☐ Attempts to avoid obstacles in familiar settings (e.g., gives wide berth; stops to wait for another to pass)
- ☐ Modifies movement to avoid obstacles that have proved difficult in the past, or that have suddenly arisen (e.g., slows or focuses attention to avoid a trip hazard)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q8. Using sporting or activity equipment (such as mats, balls, bikes, climbing equipment, musical instruments)

- ☐ Attends to properties or functions of equipment (e.g., responds upon touching; turns towards; pushes away)
- ☐ Uses equipment in familiar activities (e.g., passes items to a partner in a routine task)
- ☐ Adjusts movement response to meet requirements of equipment or activity (e.g., changes movement to keep time with different musical rhythms; moves faster in attempt to reach ball)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q9. Obtaining objects

- ☐ Uses a familiar strategy or method for obtaining objects (e.g., the same raking or swiping strategy for bringing all objects to self)
- ☐ Varies strategies for obtaining objects (e.g., one-handed or two-handed methods)
- ☐ Adapts or adjusts strategies for obtaining objects to suit changing requirements or prevent problems (e.g., alters grip to secure object from falling; retrieves object from table while moving past it)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q10. Transporting objects from place to place

- ☐ Cooperates in tasks involving transport of routine items
- ☐ Concentrates to achieve transport of self and object(s)
- ☐ Transports objects even while engaged on other aspects of activity (e.g., while manipulating objects; while talking; in crowded situations)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q11. Managing personal school equipment (such as bags, books, lunch, clothing)

- ☐ Attends to equipment when placed in hand or nearby (e.g. stills body; holds briefly)
- ☐ Achieves a component of equipment handling (e.g., holds backpack while another closes it)
- ☐ Exploits a range of movement strategies to manage personal school equipment (e.g., uses different body parts to stabilise objects; uses different ways to grip and open lunchbox and food items)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q12. Manipulating and using tools and materials (such as pencils, scissors, ruler, keyboard, mouse/switch)

- ☐ Responds to sensory properties of tools and materials (e.g. tightens and loosens grip, moves fingers over surface)
- ☐ Focuses or slows to use tools and materials with appropriate strength and control (e.g. concentrates to operate joystick on motorised wheelchair; slows to use mouse or keyboard; focuses to hold pen/ pencil lightly and press gently when writing)
- ☐ Manipulates and uses tools and materials with appropriate strength and control, while attending to other aspects of task (e.g., moves and stabilises paper while writing; releases object accurately while attending to next step of task)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q13. Using writing and drawing implements

- ☐ Scribbles, or makes marks on the paper
- ☐ Copies or traces over patterns and shapes
- ☐ Achieves legible handwriting when writing slowly and in relation to familiar writing tasks (e.g., when writing own name; when reproducing letters and numbers)
- ☐ Maintains legible and fluent handwriting in demanding or novel writing tasks (e.g., when writing at speed or for long periods; when writing with different sizes/ types of writing implements)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q14. Sharing space interactively with others

- ☐ Reacts or attends when others come close
- ☐ Manages own needs in shared space (e.g., follows instructions for avoiding bumping into others; experiments with how much room is needed to pass by another safely)
- ☐ Cooperates with others to share the space (e.g., moves responsively; moves over to share desk space)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q15. Using movement for self-expression and communication

- ☐ Uses gestures/ facial expressions interpretable to familiar others
- ☐ Uses a consistent repertoire of gestures/ facial expressions to establish meaning
- ☐ Extends and adapts repertoire of gestures/ facial expressions to suit different needs or audiences (e.g., catches a person's eye and then directs their gaze; exaggerates or alters gestures or facial expressions to imitate others or to convey more nuanced meanings)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q16. Seeking out movement experiences and challenges

- ☐ Shows awareness of activities placed nearby (e.g., lifts head; vocalises)
- ☐ Attempts greater physical involvement in classroom tasks (e.g., puts hand up to block or reduce helper involvement)
- ☐ Creates opportunities to move from classroom activities (e.g., experiments with different ways to mobilise around the classroom; finds novel movement opportunities within routine tasks)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q17. Persevering in movement tasks or activities

- ☐ Participates in movement activities that are easily achieved, or provide immediate positive outcome (e.g., moves towards desired object or person)
- ☐ Completes tasks within movement capacity with prompting or support (e.g., takes items from backpack when instructed)
- ☐ Initiates an attempt at new or more difficult aspects of tasks (e.g., exerts self to complete task; attempts task on own)
- ☐ Adapts movement strategies in response to more challenging settings (e.g., devises a new strategy for carrying objects over greater distances; uses an alternative way to travel across a different ground surface)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q18. Working within physical limits

- ☐ Relies on direct instruction to regulate involvement (e.g., takes a break when directed to do so)
- ☐ Adheres to rules regarding level of involvement and activity choice (e.g., checks with adult before engaging in new activity)
- ☐ With planning, achieves maximum involvement possible within physical limits (e.g., conserves energy by combining steps; sits where possible to achieve tasks)
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Q19. Completing tasks involving strenuous movement

- ☐ Maintains energy output for duration of simple routine tasks (e.g., for packing up; for putting away; to move between activities)
- ☐ Engages in occasional strenuous movement during activity (e.g., during stretching exercises; while moving to music)
- ☐ Manages a strenuous activity at slowed pace, or with rest periods
- ☐ **Completes strenuous movement activities comfortably (e.g., at required speed; while maintaining focus on other aspects of task)**
- ☐ Is moving towards but has not yet achieved these skills/behaviours

Please select the option that best describes your understanding

STUDENT INFORMATION

Q1. Does this student have any of the following?

Physical disability	☐ No	☐ Yes	☐ Don't Know
Intellectual disability	☐ No	☐ Yes	☐ Don't Know
Vision impairment	☐ No	☐ Yes	☐ Don't Know
Hearing impairment	☐ No	☐ Yes	☐ Don't Know
Speech/language disorder	☐ No	☐ Yes	☐ Don't Know
Behaviour disorder	☐ No	☐ Yes	☐ Don't Know

Q2. Does this student have any other impairment or condition? (please specify)

Q3. Which of the following describes the movement difficulties of this student?

Limited use of arms or fingers	☐ No	☐ Yes	☐ Don't Know
Difficulty gripping things	☐ No	☐ Yes	☐ Don't Know
Limited use of legs or feet	☐ No	☐ Yes	☐ Don't Know
A condition that restricts engagement in physical activity	☐ No	☐ Yes	☐ Don't Know

Q4. Does this student have any other movement difficulties? (please specify)

Q5. Which of the following best describes the level of assistance this student requires?

- ☐ Unable to physically participate in the classroom without extensive help or supervision
- ☐ Physically participates with the help of aids (including mobility) and/or cues and prompts
- ☐ Independent in the classroom, but difficulty with tasks such as walking short distances, using stairs without a rail, or bending to pick up objects from the floor
- ☐ No assistance requirements
- ☐ Other (please specify)

INFORMATION ABOUT YOU

Q6. How many years of experience do you have teaching or working with students with a disability?

- ☐ 0 - 2 years
- ☐ 3 - 10 years
- ☐ Over 10 years

Q7. What is your current position at this school?

- ☐ Classroom teacher
- ☐ Special education coordinator
- ☐ Specialist teacher of movement (e.g., physical education, swimming, dance)
- ☐ Therapist/ health professional
- ☐ Other (please specify)

Q8. What is your highest level of qualification to help you work with students with a disability?

- ☐ Vocational education (VET) level qualification (e.g., Certificate IV in Disability)
- ☐ Undergraduate degree (e.g., Bachelor of Disability Studies; Bachelor of Occupational Therapy)
- ☐ Postgraduate qualification (e.g., Master of Special Education)
- ☐ No formal qualification
- ☐ Other (please specify)

Appendix H. Study 1: Statistical Output Files (Unidimensional Calibration)

ConQuest: Generalised Item Response Modelling Software

SUMMARY OF THE ESTIMATION

```
=====
Estimation method was: Gauss-Hermite Quadrature with 120 nodes
No node filtering
Assumed population distribution was: Gaussian
Constraint was: DEFAULT
The Data File: Movement_One_Dimension.sav
The format: responses 1-19 (a1)
No case weights
The regression model:
Grouping Variables:
The item model: item+item*step
Slopes are fixed
Cases in file: 650 Cases in estimation: 650
Final Deviance: 22987.55601
Akaike Information Criterion (AIC): 23115.55601
Total number of estimated parameters: 64
The number of iterations: 111
Termination criteria: Max iterations=1000, Parameter Change= 0.00010
                        Deviance Change= 0.00010
Iterations terminated because the deviance convergence criteria were reached
Random number generation seed: 1.00000
Number of nodes used when drawing PVs: 2000
Number of nodes used when computing fit: 200
Number of plausible values to draw: 5
Maximum number of iterations without a deviance improvement: 100
Maximum number of Newton steps in M-step: 10
Value for obtaining finite MLEs for zero/perfects: 0.30000
```

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TABLES OF RESPONSE MODEL PARAMETER ESTIMATES

TERM 1: item

		VARIABLES			UNWEIGHTED FIT			WEIGHTED FIT			
	item	ESTIMATE	ERROR	MNSQ	Confidence Interval		T	MNSQ	Confidence Interval		T
1	1	-0.072	0.063	1.49	0.89	1.11	7.7	1.43	0.89	1.11	6.8
2	2	0.405	0.078	1.44	0.89	1.11	7	1.36	0.89	1.11	5.8
3	3	-0.205	0.073	1.04	0.89	1.11	0.7	1.08	0.89	1.11	1
4	4	-0.337	0.064	0.96	0.89	1.11	-0.8	0.94	0.89	1.11	-0.9
5	5	-0.16	0.068	0.85	0.89	1.11	-2.9	0.88	0.89	1.11	-1.9
6	6	-0.511	0.081	0.77	0.89	1.11	-4.4	0.79	0.89	1.11	-4.2
7	7	-0.275	0.068	1.03	0.89	1.11	0.5	1.07	0.89	1.11	1.2
8	8	-0.366	0.073	0.74	0.89	1.11	-5.2	0.75	0.89	1.11	-4.9
9	9	-0.489	0.071	1.03	0.89	1.11	0.6	1.05	0.9	1.1	1
10	10	0.043	0.066	0.81	0.89	1.11	-3.7	0.80	0.89	1.11	-3.7
11	11	-0.849	0.072	0.8	0.89	1.11	-3.8	0.82	0.89	1.11	-3.5
12	12	0.108	0.072	0.8	0.89	1.11	-3.9	0.79	0.9	1.1	-4.2
13	13	1.234	0.075	1.32	0.89	1.11	5.2	1.23	0.89	1.11	3.7
14	14	-0.46	0.079	0.98	0.89	1.11	-0.3	0.96	0.89	1.11	-0.7
15	15	-0.208	0.077	1.35	0.89	1.11	5.7	1.33	0.89	1.11	5.8
16	16	-0.693	0.078	0.88	0.89	1.11	-2.3	0.90	0.89	1.11	-2
17	17	0.53	0.07	0.78	0.89	1.11	-4.3	0.79	0.89	1.11	-3.8
18	18	1.1	0.076	0.97	0.89	1.11	-0.5	1.00	0.89	1.11	0
19	19	1.205	0.068	0.99	0.89	1.11	-0.1	1.02	0.89	1.11	0.7

A parameter estimate in *italics* indicates that it is constrained

Separation Reliability = 0.984

Chi-square test of parameter equality = 999.99, df = 18, Sig Level = 0.000

^ Empirical standard errors have been used

TERM 2: item-step

VARIABLES			UNWEIGHTED FIT					WEIGHTED FIT			
Item	category	ESTIMATE	ERROR	MNSQ	Confidence Interval	T	MNSQ	Confidence Interval	T		
1	0			0.64	0.89	1.11	-7.4	0.95	0.83	1.17	-0.6
1	1	-3.298	0.147	2.86	0.89	1.11	22.7	1.14	0.91	1.09	3.1
1	2	-0.608	0.126	1.82	0.89	1.11	12	1.05	0.92	1.08	1.2
1	3	0.96	0.126	9.31	0.89	1.11	59.7	1.12	0.93	1.07	3
1	4	2.946		124.46	0.89	1.11	216	1.24	0.83	1.17	2.6
2	0			10.91	0.89	1.11	65.9	1.46	0.83	1.17	4.7
2	1	-3.873	0.129	1.27	0.89	1.11	4.5	1.19	0.92	1.08	4.3
2	2	1.152	0.121	1.44	0.89	1.11	7	1.04	0.91	1.09	0.9
2	3	2.721		4.86	0.89	1.11	37.6	1.16	0.8	1.2	1.5
3	0			1.73	0.89	1.11	10.9	1.19	0.74	1.26	1.4
3	1	-4.541	0.182	0.93	0.89	1.11	-1.3	0.94	0.9	1.1	-1.2
3	2	-0.216	0.126	0.89	0.89	1.11	-2	0.96	0.93	1.07	-1
3	3	1.381	0.133	0.77	0.89	1.11	-4.6	1	0.92	1.08	-0.1
3	4	3.376		2.5	0.89	1.11	19.3	1	0.81	1.19	0
4	0			1.51	0.89	1.11	8	1.05	0.82	1.18	0.6
4	1	-3.168	0.154	0.78	0.89	1.11	-4.3	0.9	0.9	1.1	-2.2
4	2	-0.779	0.134	0.84	0.89	1.11	-3	0.97	0.91	1.09	-0.7
4	3	0.588	0.124	0.74	0.89	1.11	-5.1	0.97	0.93	1.07	-0.9
4	4	3.359		0.82	0.89	1.11	-3.4	0.99	0.83	1.17	-0.1
5	0			0.6	0.89	1.11	-8.4	0.97	0.86	1.14	-0.4
5	1	-1.978	0.126	0.7	0.89	1.11	-6	0.93	0.9	1.1	-1.5
5	2	-0.635	0.119	0.85	0.89	1.11	-2.9	0.93	0.93	1.07	-2
5	3	2.613		0.7	0.89	1.11	-6.2	0.93	0.87	1.13	-1
6	0			0.26	0.89	1.11	-19.7	0.83	0.79	1.21	-1.7
6	1	-3.564	0.146	0.67	0.89	1.11	-6.7	0.84	0.91	1.09	-3.6
6	2	0.015	0.116	0.74	0.89	1.11	-5.1	0.86	0.92	1.08	-3.7
6	3	3.548		1.4	0.89	1.11	6.5	0.91	0.84	1.16	-1.1
7	0			1.14	0.89	1.11	2.4	0.87	0.86	1.14	-1.9
7	1	-2.033	0.126	0.97	0.89	1.11	-0.6	0.99	0.91	1.09	-0.2
7	2	-0.498	0.118	0.9	0.89	1.11	-1.8	1	0.93	1.07	-0.1
7	3	2.532		4.68	0.89	1.11	36.4	1.13	0.87	1.13	2
8	0			0.44	0.89	1.11	-12.9	0.84	0.84	1.16	-2.1
8	1	-2.768	0.131	0.71	0.89	1.11	-5.8	0.85	0.92	1.08	-3.7
8	2	-0.284	0.114	0.75	0.89	1.11	-5	0.86	0.93	1.07	-4.1
8	3	3.052		0.44	0.89	1.11	-13	0.83	0.86	1.14	-2.4
9	0			3.01	0.89	1.11	24	0.86	0.84	1.16	-1.7
9	1	-2.813	0.13	1.25	0.89	1.11	4.3	0.98	0.92	1.08	-0.5
9	2	0.115	0.114	1.08	0.89	1.11	1.4	0.96	0.94	1.06	-1.3
9	3	2.697		4.98	0.89	1.11	38.3	0.96	0.87	1.13	-0.6
10	0			0.61	0.89	1.11	-8.2	0.98	0.86	1.14	-0.3
10	1	-1.894	0.12	0.71	0.89	1.11	-5.8	0.9	0.91	1.09	-2.3
10	2	-0.327	0.117	0.72	0.89	1.11	-5.6	0.9	0.94	1.06	-3.4
10	3	2.221		0.58	0.89	1.11	-8.9	0.93	0.87	1.13	-1.1
11	0			0.43	0.89	1.11	-13.2	0.95	0.83	1.17	-0.6
11	1	-2.574	0.134	0.71	0.89	1.11	-5.9	0.88	0.91	1.09	-2.8
11	2	0.098	0.117	0.98	0.89	1.11	-0.3	0.89	0.94	1.06	-3.6
11	3	2.476		0.69	0.89	1.11	-6.3	0.85	0.89	1.11	-2.9
12	0			1.35	0.89	1.11	5.7	0.96	0.85	1.15	-0.5
12	1	-3.14	0.124	0.75	0.89	1.11	-4.8	0.86	0.93	1.07	-4.1
12	2	0.385	0.112	0.68	0.89	1.11	-6.4	0.89	0.93	1.07	-3.4
12	3	2.755		0.38	0.89	1.11	-14.8	0.88	0.84	1.16	-1.4
13	0			0.93	0.89	1.11	-1.3	1.07	0.86	1.14	0.9
13	1	-3.192	0.132	1.49	0.89	1.11	7.7	1.07	0.93	1.07	2
13	2	-0.472	0.133	5	0.89	1.11	38.4	1.02	0.91	1.09	0.4
13	3	0.328	0.143	1.42	0.89	1.11	6.7	1.14	0.9	1.1	2.6
13	4	3.337		1.01	0.89	1.11	0.1	1.19	0.66	1.34	1.1
14	0			1.32	0.89	1.11	5.2	1.23	0.78	1.22	2
14	1	-3.762	0.144	0.94	0.89	1.11	-1.1	0.94	0.91	1.09	-1.4
14	2	0.901	0.117	0.8	0.89	1.11	-3.8	0.95	0.93	1.07	-1.4
14	3	2.862		0.62	0.89	1.11	-7.9	1.03	0.86	1.14	0.4
15	0			84.66	0.89	1.11	183.4	1.33	0.82	1.18	3.3
15	1	-3.413	0.136	1.09	0.89	1.11	1.5	1.11	0.92	1.08	2.7
15	2	0.031	0.114	1.63	0.89	1.11	9.5	1.14	0.93	1.07	3.5
15	3	3.382		1.57	0.89	1.11	8.7	1.14	0.82	1.18	1.5
16	0			0.38	0.89	1.11	-14.9	0.86	0.79	1.21	-1.3
16	1	-3.436	0.144	0.78	0.89	1.11	-4.2	0.89	0.91	1.09	-2.4
16	2	0.416	0.116	0.79	0.89	1.11	-4.1	0.92	0.94	1.06	-2.5
16	3	3.02		1.72	0.89	1.11	10.8	1	0.87	1.13	0
17	0			0.3	0.89	1.11	-17.7	0.81	0.85	1.15	-2.6
17	1	-3.297	0.147	0.68	0.89	1.11	-6.5	0.9	0.91	1.09	-2.2
17	2	-1.521	0.127	0.76	0.89	1.11	-4.7	0.89	0.93	1.07	-3.3
17	3	1.504	0.131	1.22	0.89	1.11	3.6	0.98	0.9	1.1	-0.3
17	4	3.314		0.3	0.89	1.11	-17.8	0.92	0.73	1.27	-0.5

18	0			0.68	0.89	1.11	-6.5	0.83	0.87	1.13	-2.5
18	1	-2.924	0.115	1.04	0.89	1.11	0.7	0.98	0.93	1.07	-0.4
18	2	0.627	0.122	0.73	0.89	1.11	-5.4	1	0.91	1.09	0
18	3	2.296		1.48	0.89	1.11	7.5	1.05	0.78	1.22	0.5
19	0			0.56	0.89	1.11	-9.4	0.85	0.86	1.14	-2.2
19	1	-2.432	0.131	0.82	0.89	1.11	-3.3	0.98	0.91	1.09	-0.4
19	2	-1.109	0.129	0.88	0.89	1.11	-2.3	1	0.93	1.07	0.1
19	3	0.924	0.139	5.28	0.89	1.11	40.1	1.05	0.89	1.11	0.9
19	4	2.617		1.14	0.89	1.11	2.4	1.29	0.73	1.27	2

ConQuest: Generalised Item Response Modelling Software**TABLES OF POPULATION MODEL PARAMETER ESTIMATES****REGRESSION COEFFICIENTS****Regression Variable**

CONSTANT -0.013 0.09

A parameter estimate in italics indicates that it is constrained

CONDITIONAL COVARIANCE/CORRELATION MATRIX**Dimension_1**

Variance 4.988094 (0.319)

A parameter estimate in italics indicates that it is constrained

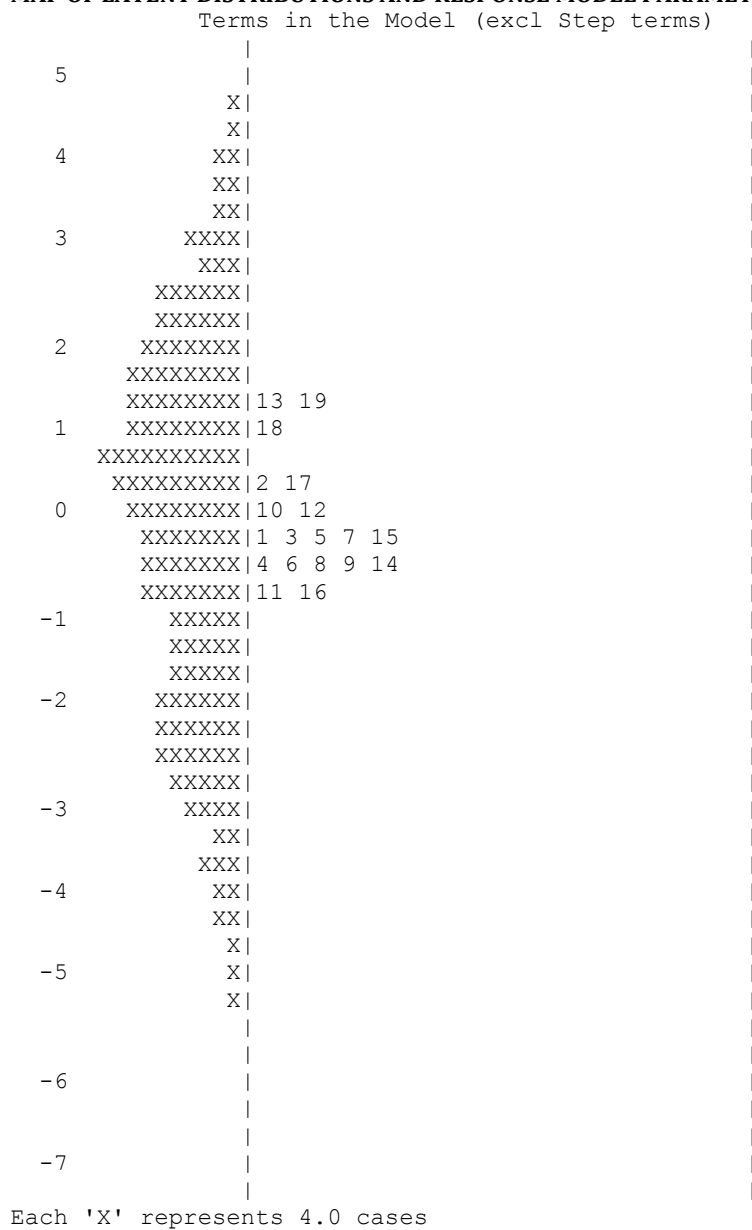
RELIABILITY COEFFICIENTS**Dimension: (Dimension_1)**

MLE Person separation RELIABILITY: Unavailable

WLE Person separation RELIABILITY: 0.967

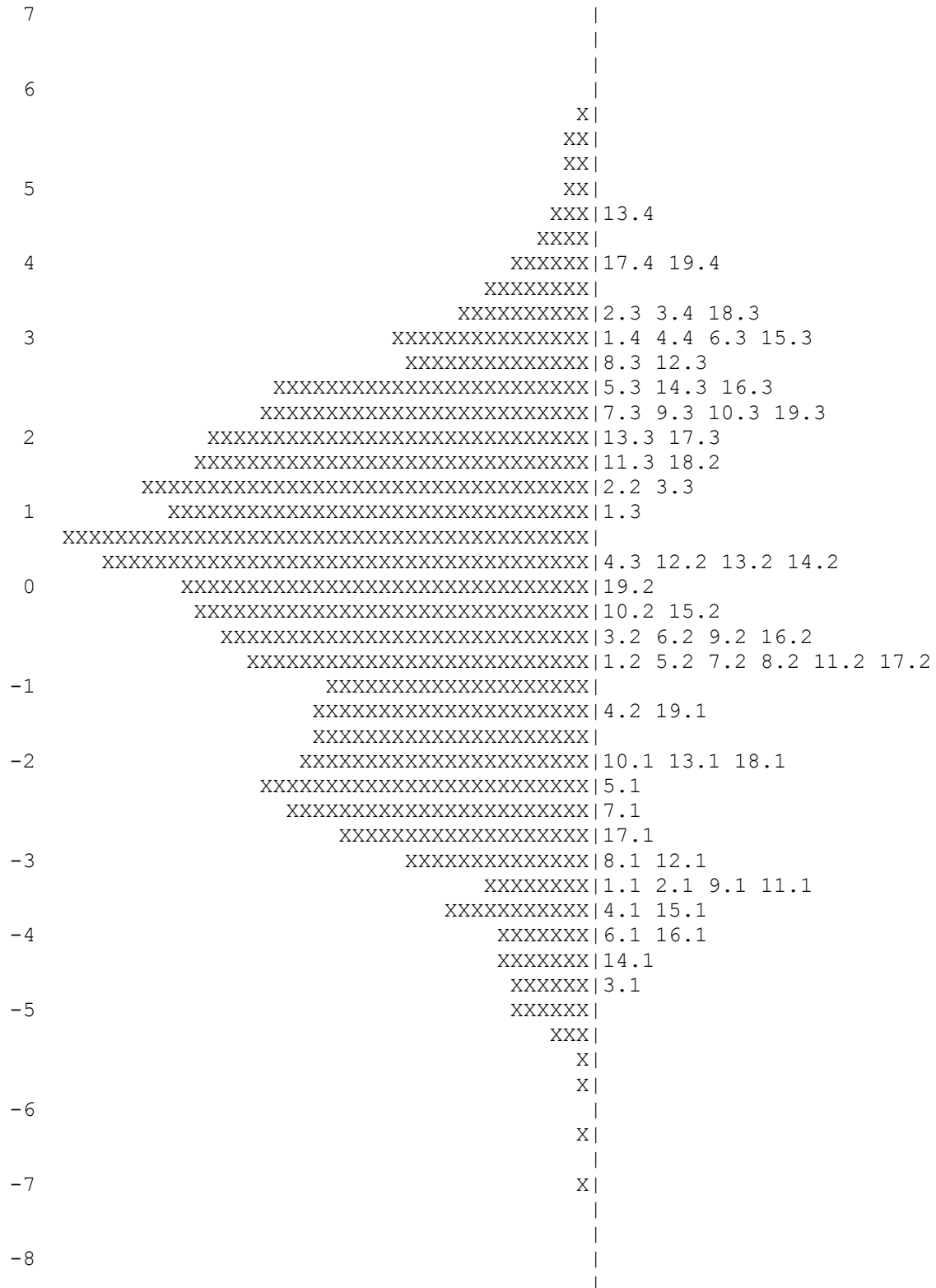
EAP/PV RELIABILITY: 0.971

ConQuest: Generalised Item Response Modelling Software Thu Oct 20 12:32 2016
MAP OF LATENT DISTRIBUTIONS AND RESPONSE MODEL PARAMETER ESTIMATES



ConQuest: Generalised Item Response Modelling Software Thu Oct 20 12:32 2016**MAP OF LATENT DISTRIBUTIONS AND THRESHOLDS**

Generalised-Item Thresholds



Each 'X' represents 1.0 cases

The labels for thresholds show the levels of item, and category, respectively

GENERALISED ITEM ANALYSIS

Group All Students

item:1 (1)

Cases for this item 650 Item-Rest Cor. 0.73 Item-Total Cor. 0.77

Item Threshold(s): -3.43 -0.78 0.94 2.99 Weighted MNSQ 1.43

Item Delta(s): -3.37 -0.68 0.89 2.87

Label	Score	Count	tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
0	0	70	10.77	-0.49	-14.32	0.000	-3.423	1.249
1	1	170	26.15	-0.36	-9.91	0.000	-1.396	1.540
2	2	169	26	0.07	1.71	0.089	0.213	1.374
3	3	162	24.92	0.35	9.51	0.000	1.352	1.458
4	4	79	12.15	0.4	11.11	0	2.419	1.676

item:2 (2)

Cases for this item 650 Item-Rest Cor. 0.60 Item-Total Cor. 0.63

Item Threshold(s): -3.47 1.40 3.29 Weighted MNSQ 1.36

Item Delta(s): -3.47 1.56 3.13

Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
0	0	75	11.54	-0.32	-8.63	0.000	-2.178	1.905
1	1	368	56.62	-0.32	-8.51	0.000	-0.671	1.895
2	2	144	22.15	0.35	9.51	0	1.434	1.337
3	3	63	9.69	0.39	10.67	0	2.746	1.651

item:3 (3)

Cases for this item 650 Item-Rest Cor. 0.78 Item-Total Cor. 0.81

Item Threshold(s): -4.76 -0.57 1.22 3.29 Weighted MNSQ 1.08

Item Delta(s): -4.75 -0.42 1.18 3.17

Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
0	0	31	4.77	-0.28	-7.46	0.000	-3.129	1.575
1	1	226	34.77	-0.62	-20.26	0.000	-1.927	1.535
2	2	179	27.54	0.13	3.32	0.001	0.433	1.191
3	3	150	23.08	0.41	11.35	0	1.577	1.142
4	4	64	9.85	0.43	12	0	2.929	1.569

item:4 (4)

Cases for this item 650 Item-Rest Cor. 0.83 Item-Total Cor. 0.86

Item Threshold(s): -3.59 -1.23 0.39 3.08 Weighted MNSQ 0.94

Item Delta(s): -3.51 -1.12 0.25 3.02

Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
0	0	62	9.54	-0.44	-12.35	0.000	-3.359	1.477
1	1	141	21.69	-0.51	-14.96	0.000	-2.098	1.207
2	2	154	23.69	-0.06	-1.44	0.151	-0.225	1.169
3	3	214	32.92	0.44	12.48	0	1.337	1.158
4	4	79	12.15	0.47	13.62	0	2.807	1.339

item:5 (5)

Cases for this item 650 Item-Rest Cor. 0.82 Item-Total Cor. 0.84

Item Threshold(s): -2.33 -0.64 2.49 Weighted MNSQ 0.88

Item Delta(s): -2.14 -0.80 2.45

Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
0	0	123	18.92	-0.61	-19.81	0.000	-2.994	1.359
1	1	139	21.38	-0.31	-8.21	0.000	-1.286	1.164
2	2	271	41.69	0.32	8.58	0	0.797	1.24
3	3	117	18	0.54	16.5	0	2.565	1.323

item:6 (6)

Cases for this item 650 Item-Rest Cor. 0.81 Item-Total Cor. 0.83

Item Threshold(s): -4.10 -0.50 3.07 Weighted MNSQ 0.79

Item Delta(s): -4.07 -0.50 3.04

Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
0	0	48	7.38	-0.44	-12.4	0.00	-3.898	1.132
1	1	225	34.62	-0.54	-16.24	0.00	-1.605	1.339
2	2	293	45.08	0.42	11.69	0	0.953	1.211
3	3	84	12.92	0.49	14.12	0	2.833	1.41

item:7 (7)

Cases for this item 650 Item-Rest Cor. 0.77 Item-Total Cor. 0.80

Item Threshold(s): -2.48 -0.65 2.30 Weighted MNSQ 1.07

Item Delta(s): -2.31 -0.77 2.26

Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
0	0	115	17.69	-0.61	-19.5	0.00	-3.130	1.312
1	1	145	22.31	-0.27	-7.03	0.00	-1.071	1.333
2	2	261	40.15	0.31	8.39	0	0.786	1.311
3	3	129	19.85	0.48	13.74	0	2.165	1.646

item:8 (8)

Cases for this item

Item Threshold(s):

Item Delta(s):

Label Score

0 0

1 1

2 2

3 3

650 Item-Rest Cor. 0.84 Item-Total Cor. 0.86

-3.21 -0.61 2.72 Weighted MNSQ 0.75

-3.13 -0.65 2.69

Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
80	12.31	-0.53	-16.07	0.00	-3.516	1.214
184	28.31	-0.44	-12.3	0.00	-1.452	1.230
283	43.54	0.34	9.11	0	0.816	1.182
103	15.85	0.56	17.18	0	2.783	1.234

item:9 (9)

Cases for this item

Item Threshold(s):

Item Delta(s):

Label Score

0 0

1 1

2 2

3 3

650 Item-Rest Cor. 0.76 Item-Total Cor. 0.79

-3.35 -0.39 2.28 Weighted MNSQ 1.05

-3.30 -0.37 2.21

Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
75	11.54	-0.5	-14.72	0.00	-3.423	1.464
205	31.54	-0.37	-10.09	0.00	-1.154	1.487
241	37.08	0.24	6.38	0	0.65	1.308
129	19.85	0.54	16.17	0	2.37	1.546

item:10 (10)

Cases for this item

Item Threshold(s):

Item Delta(s):

Label Score

0 0

1 1

2 2

3 3

650 Item-Rest Cor. 0.85 Item-Total Cor. 0.87

-2.02 -0.19 2.34 Weighted MNSQ 0.80

-1.85 -0.28 2.26

Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
144	22.15	-0.64	-21.46	0.00	-2.826	1.357
156	24	-0.29	-7.65	0.00	-1.072	1.142
226	34.77	0.36	9.74	0	1	1.092
124	19.08	0.56	17.24	0	2.559	1.286

item:11 (11)

Cases for this item

Item Threshold(s):

Item Delta(s):

Label Score

0 0

1 1

2 2

3 3

650 Item-Rest Cor. 0.83 Item-Total Cor. 0.85

-3.49 -0.77 1.71 Weighted MNSQ 0.82

-3.42 -0.75 1.63

Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
68	10.46	-0.49	-14.21	0.00	-3.427	1.219
178	27.38	-0.48	-13.82	0.00	-1.689	1.310
232	35.69	0.17	4.29	0	0.471	1.198
172	26.46	0.64	21.21	0	2.287	1.351

item:12 (12)

Cases for this item

Item Threshold(s):

Item Delta(s):

Label Score

0 0

1 1

2 2

3 3

650 Item-Rest Cor. 0.82 Item-Total Cor. 0.84

-3.06 0.44 2.95 Weighted MNSQ 0.79

-3.03 0.49 2.86

Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
91	14	-0.52	-15.62	0.000	-3.053	1.495
265	40.77	-0.39	-10.77	0.000	-1.036	1.419
209	32.15	0.42	11.93	0	1.289	1.045
85	13.08	0.52	15.41	0	2.966	1.178

item:13 (13)

Cases for this item

Item Threshold(s):

Item Delta(s):

Label Score

0 0

1 1

2 2

3 3

4 4

650 Item-Rest Cor. 0.76 Item-Total Cor. 0.79

-2.02 0.53 1.81 4.62 Weighted MNSQ 1.23

-1.96 0.76 1.56 4.57

Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
148	22.77	-0.61	-19.81	0.000	-2.637	1.438
215	33.08	-0.16	-4.19	0.000	-0.546	1.501
131	20.15	0.25	6.57	0	1.048	1.27
132	20.31	0.45	12.97	0	1.969	1.357
24	3.69	0.27	7.15	0	3.316	1.55

item:14 (14)

Cases for this item

Item Threshold(s):

Item Delta(s):

Label Score

0 0

1 1

2 2

3 3

650 Item-Rest Cor. 0.75 Item-Total Cor. 0.78

-4.23 0.33 2.52 Weighted MNSQ 0.96

-4.22 0.44 2.40

Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
46	7.08	-0.33	-9.02	0.000	-2.900	1.372
297	45.69	-0.55	-16.86	0.000	-1.362	1.681
198	30.46	0.36	9.84	0	1.158	1.211
109	16.77	0.52	15.55	0	2.549	1.301

item:15 (15)

Cases for this item

Item Threshold(s):

Item Delta(s):

Label Score

0 0

1 1

2 2

3 3

650 Item-Rest Cor. 0.65 Item-Total Cor. 0.68

-3.65 -0.18 3.21 Weighted MNSQ 1.33

-3.62 -0.18 3.17

Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1
64	9.85	-0.36	-9.73	0.000	-2.669	1.810
237	36.46	-0.41	-11.3	0.000	-1.238	1.732
273	42	0.35	9.44	0	0.87	1.577
76	11.69	0.41	11.28	0	2.576	1.565

item:16 (16)									
Cases for this item		650	Item-Rest Cor.		0.79	Item-Total Cor.		0.81	
Item Threshold(s):		-4.15	-0.32	2.39	Weighted MNSQ		0.90		
Item Delta(s):		-4.13	-0.28	2.33					
Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1	
0	0	47	7.23	-0.42	-11.86	0.00	-3.766	1.167	
1	1	238	36.62	-0.53	-15.77	0.00	-1.534	1.450	
2	2	244	37.54	0.33	8.82	0	0.895	1.188	
3	3	121	18.62	0.53	15.72	0	2.42	1.497	
item:17 (17)									
Cases for this item		650	Item-Rest Cor.		0.85	Item-Total Cor.		0.87	
Item Threshold(s):		-2.91	-0.90	1.95	3.98	Weighted MNSQ		0.79	
Item Delta(s):		-2.77	-0.99	2.03	3.84				
Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1	
0	0	92	14.15	-0.58	-18.18	0.00	-3.391	1.157	
1	1	146	22.46	-0.38	-10.61	0.00	-1.552	1.193	
2	2	257	39.54	0.22	5.74	0	0.552	1.14	
3	3	118	18.15	0.43	12.2	0	1.979	1.175	
4	4	37	5.69	0.38	10.6	0	3.576	1.284	
item:18 (18)									
Cases for this item		650	Item-Rest Cor.		0.76	Item-Total Cor.		0.79	
Item Threshold(s):		-1.85	1.61	3.55	Weighted MNSQ		1.00		
Item Delta(s):		-1.82	1.73	3.40					
Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1	
0	0	164	25.23	-0.67	-22.94	0.000	-2.680	1.400	
1	1	300	46.15	0.05	1.15	0.249	0.090	1.489	
2	2	134	20.62	0.39	10.93	0	1.65	1.116	
3	3	52	8	0.4	11.12	0	3.086	1.508	
item:19 (19)									
Cases for this item		650	Item-Rest Cor.		0.82	Item-Total Cor.		0.84	
Item Threshold(s):		-1.43	0.18	2.10	3.97	Weighted MNSQ		1.02	
Item Delta(s):		-1.23	0.10	2.13	3.82				
Label	Score	Count	% tot	Pt Bis	t	sig	PV1Avg:1	PV1 SD:1	
0	0	184	28.31	-0.72	-26.33	0.000	-2.634	1.346	
1	1	149	22.92	-0.08	-1.94	0.053	-0.289	1.209	
2	2	180	27.69	0.28	7.4	0	0.917	1.157	
3	3	101	15.54	0.43	12.04	0	2.2	1.42	
4	4	36	5.54	0.33	8.97	0	3.045	1.227	

The following traditional statistics are only meaningful for complete designs and when the amount of missing data is minimal.

In this analysis 0.00% of the data are missing.

The following results are scaled to assume that a single response was provided for each item.

N	650
Mean	30.99
Standard Deviation	15.02
Variance	225.67
Skewness	-0.06
Kurtosis	-0.94
Standard error of mean	0.59
Standard error of measurement	2.65
Coefficient Alpha	0.97

Appendix I. Study 1: Statistical Output Files (Five-dimensional Calibration)

ConQuest: Generalised Item Response Modelling Software

SUMMARY OF THE ESTIMATION

```
=====
Estimation method was: MonteCarlo with 6000 nodes
Node filtering not applicable
Assumed population distribution was: Gaussian
Constraint was: CASES
The Data File:
C:\Users\lgale\Desktop\October2016_PhysDiff650\20161016_PhysDiff650.sav
The format: responses 1-19 (a1)
No case weights
The regression model:
Grouping Variables:
The item model: item+item*step
Slopes are fixed
Cases in file: 650 Cases in estimation: 650
Final Deviance: 22321.39827
Akaike Information Criterion (AIC): 22475.39827
Total number of estimated parameters: 77
The number of iterations: 67
Termination criteria: Max iterations=1000, Parameter Change= 0.00010
                        Deviance Change= 0.00010
Iterations terminated because the deviance convergence criteria were reached
Random number generation seed: 1.00000
Number of nodes used when drawing PVs: 2000
Number of nodes used when computing fit: 200
Number of plausible values to draw: 5
Maximum number of iterations without a deviance improvement: 100
Maximum number of Newton steps in M-step: 10
Value for obtaining finite MLEs for zero/perfects: 0.30000
```

ConQuest: Generalised Item Response Modelling Software Tue Nov 01 07:40 2016

TABLES OF RESPONSE MODEL PARAMETER ESTIMATES

TERM 1: item

VARIABLES		UNWEIGHTED FIT						WEIGHTED FIT			
item	ESTIMATE	ERROR	MNSQ	Confidence Interval		T	MNSQ	Confidence Interval		T	
1	1	-0.046	0.057	1.21	0.89	1.11	2.3	1.14	0.89	1.11	2.2
2	2	0.38	0.071	1.11	0.89	1.11	2.4	1.12	0.89	1.11	1.9
3	3	-0.2	0.067	0.92	0.89	1.11	2.4	1.14	0.89	1.11	2.5
4	4	-0.279	0.058	0.86	0.89	1.11	-2.8	0.84	0.89	1.11	-2.8
5	5	-0.174	0.073	0.97	0.89	1.11	-1.4	0.96	0.89	1.11	-0.5
6	6	-0.565	0.081	0.84	0.89	1.11	-3.6	0.85	0.89	1.11	-3.3
7	7	-0.304	0.072	1.2	0.89	1.11	2.3	1.15	0.89	1.11	2.5
8	8	-0.439	0.079	0.84	0.89	1.11	-2.9	0.85	0.89	1.11	-2.3
9	9	-0.578	0.077	1.09	0.89	1.11	3.1	1.18	0.89	1.11	3.8
10	10	0.064	0.07	0.92	0.89	1.11	-0.9	0.91	0.89	1.11	-1.4
11	11	-1.022	0.076	0.87	0.89	1.11	-2.4	0.88	0.89	1.11	-1.6
12	12	0.162	0.078	0.95	0.89	1.11	-1.3	0.89	0.89	1.11	-1.4
13	13	1.314	0.082	1.34	0.89	1.11	2.7	1.32	0.89	1.11	2.3
14	14	-0.401	0.068	0.84	0.89	1.11	-3.3	0.84	0.89	1.11	-3.1
15	15	-0.155	0.07	1.06	0.89	1.11	1.7	1.07	0.89	1.11	1.7
16	16	-0.808	0.079	1.06	0.89	1.11	0	1.07	0.89	1.11	0.4
17	17	0.653	0.07	0.82	0.89	1.11	-3.1	0.88	0.89	1.11	-2.7
18	18	1.357	0.078	1.04	0.89	1.11	1.6	1.12	0.89	1.11	2
19	19	1.482	0.065	1.01	0.89	1.11	-0.5	1.06	0.88	1.12	1

A parameter estimate in italics indicates that it is constrained

Separation Reliability = 0.991

Chi-square test of parameter equality = 999.99, df = 18, Sig Level = 0.000

^ Empirical standard errors have been used

TERM 2: item-step

VARIABLES		UNWEIGHTED FIT					WEIGHTED FIT				
item	category	ESTIMATE	ERROR	MNSQ	Confidence Interval		T	MNSQ	Confidence Interval		T
1	0			0.38	0.89	1.11	-15	0.87	0.83	1.17	-1.5
1	1	-2.947	0.11	1.15	0.89	1.11	2.6	1.03	0.92	1.08	0.8
1	2	-0.536	0.095	1.08	0.89	1.11	1.4	0.98	0.92	1.08	-0.4
1	3	0.808	0.103	1.84	0.89	1.11	12.2	1.05	0.92	1.08	1.2
1	4	2.675		10.57	0.89	1.11	64.6	1.1	0.83	1.17	1.2
2	0			2.43	0.89	1.11	18.6	1.21	0.83	1.17	2.3
2	1	-3.427	0.109	1.05	0.89	1.11	0.9	1.03	0.92	1.08	0.7
2	2	1.03	0.104	0.95	0.89	1.11	-0.9	0.97	0.91	1.09	-0.8
2	3	2.397		1.38	0.89	1.11	6.1	1.07	0.81	1.19	0.7
3	0			4.77	0.89	1.11	37	1.34	0.73	1.27	2.3
3	1	-5.184	0.138	1.22	0.89	1.11	3.7	0.99	0.89	1.11	-0.1
3	2	-0.321	0.103	1.04	0.89	1.11	0.8	0.98	0.92	1.08	-0.5
3	3	1.593	0.11	0.78	0.89	1.11	-4.2	1.01	0.91	1.09	0.1
3	4	3.912		2.67	0.89	1.11	21	1.06	0.8	1.2	0.6
4	0			1.62	0.89	1.11	9.4	1.03	0.82	1.18	0.3
4	1	-2.83	0.112	0.68	0.89	1.11	-6.5	0.85	0.91	1.09	-3.3
4	2	-0.674	0.097	0.82	0.89	1.11	-3.5	0.93	0.92	1.08	-1.6
4	3	0.44	0.097	0.7	0.89	1.11	-6	0.93	0.93	1.07	-2
4	4	3.064		0.53	0.89	1.11	-10.2	0.95	0.83	1.17	-0.6
5	0			0.79	0.89	1.11	-4.1	1.04	0.85	1.15	0.5
5	1	-2.355	0.101	0.73	0.89	1.11	-5.4	0.95	0.91	1.09	-1
5	2	-0.648	0.096	0.85	0.89	1.11	-2.7	0.95	0.92	1.08	-1.2
5	3	3.003		0.74	0.89	1.11	-5.2	0.96	0.85	1.15	-0.6
6	0			0.25	0.89	1.11	-20.1	0.85	0.78	1.22	-1.4
6	1	-4.081	0.119	0.67	0.89	1.11	-6.8	0.86	0.9	1.1	-3.1
6	2	0.034	0.096	0.72	0.89	1.11	-5.6	0.87	0.92	1.08	-3.3
6	3	4.047		2.02	0.89	1.11	14.3	0.93	0.82	1.18	-0.8
7	0			1.53	0.89	1.11	8.2	0.89	0.85	1.15	-1.4
7	1	-2.411	0.1	0.95	0.89	1.11	-0.8	0.99	0.91	1.09	-0.1
7	2	-0.507	0.096	0.99	0.89	1.11	-0.2	1.05	0.92	1.08	1.4
7	3	2.918		3.37	0.89	1.11	27	1.27	0.86	1.14	3.5
8	0			0.45	0.89	1.11	-12.6	0.89	0.83	1.17	-1.4
8	1	-3.467	0.11	0.91	0.89	1.11	-1.6	0.9	0.91	1.09	-2.1
8	2	-0.291	0.098	0.84	0.89	1.11	-3	0.91	0.91	1.09	-2.1
8	3	3.758		0.43	0.89	1.11	-13.1	0.88	0.84	1.16	-1.5
9	0			14.66	0.89	1.11	78.3	0.92	0.83	1.17	-0.9
9	1	-3.504	0.107	1.83	0.89	1.11	12.1	1.06	0.91	1.09	1.3
9	2	0.142	0.097	1.3	0.89	1.11	5	1.03	0.92	1.08	0.7
9	3	3.362		7.47	0.89	1.11	51.7	1.04	0.86	1.14	0.6
10	0			0.83	0.89	1.11	-3.3	1.06	0.85	1.15	0.8
10	1	-2.251	0.099	0.73	0.89	1.11	-5.3	0.92	0.91	1.09	-1.8
10	2	-0.325	0.097	0.81	0.89	1.11	-3.7	0.94	0.93	1.07	-1.6
10	3	2.577		0.66	0.89	1.11	-7	1.03	0.86	1.14	0.4
11	0			0.4	0.89	1.11	-14.2	0.95	0.82	1.18	-0.5
11	1	-3.227	0.104	0.89	0.89	1.11	-2	0.91	0.9	1.1	-1.8
11	2	0.111	0.096	0.98	0.89	1.11	-0.3	0.91	0.92	1.08	-2.4
11	3	3.116		0.91	0.89	1.11	-1.7	0.91	0.87	1.13	-1.5
12	0			5.37	0.89	1.11	40.6	1.05	0.84	1.16	0.6
12	1	-3.88	0.112	0.86	0.89	1.11	-2.7	0.94	0.92	1.08	-1.5
12	2	0.448	0.101	0.78	0.89	1.11	-4.3	0.94	0.92	1.08	-1.5
12	3	3.432		0.41	0.89	1.11	-14	0.93	0.82	1.18	-0.8
13	0			1.04	0.89	1.11	0.7	1.11	0.86	1.14	1.4
13	1	-3.748	0.124	1.12	0.89	1.11	2.1	1.07	0.92	1.08	1.8
13	2	-0.754	0.109	4.16	0.89	1.11	32.9	1.09	0.9	1.1	1.6
13	3	4.502		0.92	0.89	1.11	-1.5	1.12	0.67	1.33	0.7
14	0			0.72	0.89	1.11	-5.5	1.04	0.78	1.22	0.4
14	1	-3.3	0.106	0.78	0.89	1.11	-4.3	0.86	0.92	1.08	-3.7
14	2	0.783	0.093	0.76	0.89	1.11	-4.8	0.9	0.94	1.06	-3
14	3	2.517		0.63	0.89	1.11	-7.7	0.97	0.86	1.14	-0.5
15	0			4.48	0.89	1.11	35.1	1.15	0.82	1.18	1.6
15	1	-2.967	0.108	0.9	0.89	1.11	-1.8	0.99	0.93	1.07	-0.2
15	2	-0.055	0.091	1.08	0.89	1.11	1.5	1.02	0.93	1.07	0.6
15	3	3.022		0.89	0.89	1.11	-2	1.03	0.83	1.17	0.4
16	0			0.43	0.89	1.11	-13.2	0.94	0.78	1.22	-0.5
16	1	-4.164	0.113	0.88	0.89	1.11	-2.2	0.97	0.9	1.1	-0.6
16	2	0.485	0.096	0.85	0.89	1.11	-2.7	0.99	0.93	1.07	-0.3
16	3	3.679		2.2	0.89	1.11	16.3	1.08	0.86	1.14	1.1
17	0			0.28	0.89	1.11	-18.7	0.81	0.83	1.17	-2.3
17	1	-4.11	0.132	0.63	0.89	1.11	-7.6	0.9	0.9	1.1	-2.1
17	2	-1.764	0.113	0.75	0.89	1.11	-4.9	0.92	0.92	1.08	-2.2
17	3	1.803	0.121	2.57	0.89	1.11	20	0.99	0.9	1.1	-0.2
17	4	4.072		0.49	0.89	1.11	-11.5	0.99	0.73	1.27	-0.1
18	0			0.94	0.89	1.11	-1.1	0.94	0.85	1.15	-0.7
18	1	-3.553	0.111	1.28	0.89	1.11	4.6	1.06	0.92	1.08	1.4
18	2	0.71	0.114	0.72	0.89	1.11	-5.6	1.01	0.91	1.09	0.2
18	3	2.844		1.89	0.89	1.11	12.8	1.06	0.78	1.22	0.5
19	0			0.5	0.89	1.11	-11.1	0.87	0.84	1.16	-1.6
19	1	-3.088	0.119	0.85	0.89	1.11	-2.7	0.97	0.91	1.09	-0.5
19	2	-1.281	0.112	0.86	0.89	1.11	-2.6	0.99	0.93	1.07	-0.2
19	3	1.138	0.129	4.85	0.89	1.11	37.5	1.04	0.89	1.11	0.7
19	4	3.231		0.79	0.89	1.11	-4.2	1.33	0.72	1.28	2.2

CONDITIONAL COVARIANCE/CORRELATION MATRIX

Dimension	0	1	2	3	4
Dimension_1		5.447359	5.448442	3.461676	5.485256
Dimension_2	0.991236		7.641602	4.663285	7.730131
Dimension_3	0.94274	0.961719		4.988532	8.306727
Dimension_4	0.911431	0.893046	0.908412		5.117514
Dimension_5	0.927824	0.951042	0.971787	0.911	
Variance	3.997177 (0.222)	7.555522 (0.419)	8.35618 (0.464)	3.608876 (0.200)	8.74399 (0.485)

A parameter estimate in italics indicates that it is constrained

Values below the diagonal are correlations and values above are covariances

RELIABILITY COEFFICIENTS**Dimension: (Dimension_1)**

MLE Person separation RELIABILITY: Unavailable

WLE Person separation RELIABILITY: 0.812

EAP/PV RELIABILITY: 0.949

Dimension: (Dimension_2)

MLE Person separation RELIABILITY: Unavailable

WLE Person separation RELIABILITY: 0.883

EAP/PV RELIABILITY: 0.961

Dimension: (Dimension_3)

MLE Person separation RELIABILITY: Unavailable

WLE Person separation RELIABILITY: 0.880

EAP/PV RELIABILITY: 0.953

Dimension: (Dimension_4)

MLE Person separation RELIABILITY: Unavailable

WLE Person separation RELIABILITY: 0.738

EAP/PV RELIABILITY: 0.892

Dimension: (Dimension_5)

MLE Person separation RELIABILITY: Unavailable

WLE Person separation RELIABILITY: 0.884

EAP/PV RELIABILITY: 0.946

ConQuest: Generalised Item Response Modelling Software Tue Nov 01 07:40 2016
MAP OF LATENT DISTRIBUTIONS AND RESPONSE MODEL PARAMETER ESTIMATES

Dimension		Terms in the Model (excl Step terms)				
	Dim_1	Dim_2	Dim_3	Dim_4	Dim_5	
7						
6		X	X		X	
5		X	X		X	
4	X	XX	XX	X	XX	
3	XX	XXXX	XXX	XX	XXX	
2	XXXX	XXXX	XXXX	XXXX	XXXX	
1	XXXXXXXX	XXXX	XXXXXXXX	XXXXXXXX	XXXX	13 18 19
0	XXXXXXXX	XXXX	XXXX	XXXXXXXX	XXXX	17
-1	XXXX	XXXX	XXXX	XXXX	XXXX	2 10 12
-2	XXXX	XXXX	XXXX	XXXX	XXXX	1 3 4 5 7 15
-3	XX	XX	XX	XX	XX	6 8 9 14
-4	X	XX	XX	X	XX	11 16
-5	X	X	X		X	
-6		X	X			
-7					X	
-8		X				

=====

Each 'X' represents 6.2 cases

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Dimension 1		Dimension 2		Dimension 3		Dimension 4		Dimension 5	
Balance, postural control and positioning		Transportation of self and objects		Manipulation and use of objects and tools		Self-management, communication, social interaction		Fitness, endurance, motivation	
8		8		8		8		8	
					X				X
7		7		7	X			7	
			X		X				XX
6		6	XX	6	XX			6	X
			X		XXX 13.4				XXX
5	X	5	XXX	5	XXXX		X	5	XXXX
	XX		XXXX		XXXX		X		XXXX 17.4 19.4
	XX		XXXX		XXXX		XX		XXXX 18.3
4	XXXX	4	XXXXXXXX	4	XXXXXXXX		XX	4	XXXXXXXX
	XXXX		XXXX 3.4 6.3		XXXXXXXX 12.3		XXXX		XXXX
3	XXXXXXXX	3	XXXXXXXXXXXX	3	XXXXXXXXXXXX 8.3		XXXX	3	XXXXXXXX
	XXXXXXXX 1.4 4.4		XXXXXXXXXXXX 5.3 10.3		XXXXXXXXXXXX 9.3		XXXXXXXX 2.3 15.3		XXXXXXXXXXXX 16.3
	XXXXXXXX		XXXXXXXXXXXX 7.3		XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX 17.3 19.3
2	XXXXXXXXXXXX	2	XXXXXXXXXXXX	2	XXXXXXXXXXXX 11.3 13.3		XXXXXXXXXXXX 14.3	2	XXXXXXXXXXXX 18.2
	XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX
	XXXXXXXXXXXX		XXXXXXXXXXXX 3.3		XXXXXXXXXXXX		XXXXXXXXXXXX 2.2		XXXXXXXXXXXX
1	XXXXXXXXXXXX 1.3	1	XXXXXXXXXXXX	1	XXXXXXXXXXXX	1	XXXXXXXXXXXX	1	XXXXXXXXXXXX
	XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX 12.2 13.2		XXXXXXXXXXXX		XXXXXXXXXXXX
0	XXXXXXXXXXXX 4.3	0	XXXXXXXXXXXX	0	XXXXXXXXXXXX	0	XXXXXXXXXXXX 14.2	0	XXXXXXXXXXXX 19.2
	XXXXXXXXXXXX		XXXXXXXXXXXX 10.2		XXXXXXXXXXXX		XXXXXXXXXXXX 15.2		XXXXXXXXXXXX 16.2
	XXXXXXXXXXXX 1.2		XXXXXXXXXXXX 3.2 5.2 6.2 7.2		XXXXXXXXXXXX 8.2 9.2		XXXXXXXXXXXX		XXXXXXXXXXXX
-1	XXXXXXXXXXXX 4.2	-1	XXXXXXXXXXXX	-1	XXXXXXXXXXXX 11.2	-1	XXXXXXXXXXXX	-1	XXXXXXXXXXXX 17.2
	XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX
	XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX
-2	XXXXXXXXXXXX	-2	XXXXXXXXXXXX	-2	XXXXXXXXXXXX	-2	XXXXXXXXXXXX	-2	XXXXXXXXXXXX 18.1
	XXXXXXXXXXXX		XXXXXXXXXXXX 10.1		XXXXXXXXXXXX 13.1		XXXXXXXXXXXX		XXXXXXXXXXXX
-3	XXXXXXXXXXXX 1.1 4.1	-3	XXXXXXXXXXXX 5.1 7.1	-3	XXXXXXXXXXXX	-3	XXXXXXXXXXXX 2.1	-3	XXXXXXXXXXXX
	XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX 12.1		XXXXX 15.1		XXXXXXXXXXXX
	XXXXXXXXXXXX		XXXXXXXXXXXX		XXXXXXXXXXXX 8.1 9.1 11.1		XXXXX 14.1		XXXXXXXXXXXX 17.1
-4	XXXX	-4	XXXX	-4	XXXX	-4	XX	-4	XXXX
	XXXX		XXXX 6.1		XXXX		XX		XXXX
-5	X	-5	XX	-5	XX	-5		-5	XXXX 16.1
			XXX 3.1		XX				XX
-6	X	-6	XX	-6	XXXX	-6		-6	XXXX
			XX		XX				XX
-7		-7	XX	-7	XX	-7		-7	X
					XX				XX
-8		-8		-8		-8		-8	

Each 'X' represents 1.4 cases. The labels for the thresholds show the levels of item, and category, respectively

GENERALISED ITEM ANALYSIS

Group All Students

Item:1 (1)

Cases for this item 650 Item-Rest Cor. 0.73 Item-Total Cor. 0.77

Item Threshold(s): -3.11 -0.72 0.82 2.75 Weighted MNSQ 1.14

Item Delta(s): -3.03 -0.60 0.75 2.61

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	70	10.77	-0.49	-14.32	0.000	-3.082	1.100	-4.277	1.536	-4.454	1.676	-2.620	1.084	-4.410	1.812
1	170	26.15	-0.36	-9.91	0.000	-1.200	1.364	-1.609	1.889	-1.607	2.083	-0.944	1.430	-1.498	2.207
2	169	26	0.07	1.71	0.089	0.111	1.15	0.208	1.587	0.393	1.885	0.178	1.344	0.441	1.932
3	162	24.92	0.35	9.51	0	1.265	1.262	1.758	1.735	1.733	2.015	0.938	1.523	1.642	2.099
4	79	12.15	0.4	11.11	0	2.306	1.349	3.097	1.841	2.902	2.031	1.858	1.451	2.863	2.143

Item: 2

Cases for this item 650 Item-Rest Cor. 0.60 Item-Total Cor. 0.63

Item Threshold(s): -3.07 1.22 2.94 Weighted MNSQ 1.12

Item Delta(s): -3.06 1.41 2.75

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	75	11.54	-0.32	-8.63	0.000	-1.944	1.572	-2.496	2.254	-2.548	2.531	-2.077	1.481	-2.523	2.757
1	368	56.62	-0.32	-8.51	0	-0.524	1.736	-0.688	2.444	-0.766	2.578	-0.569	1.473	-0.772	2.532
2	144	22.15	0.35	9.51	0	1.206	1.256	1.612	1.736	1.801	1.826	1.364	1.113	1.857	1.902
3	63	9.69	0.39	10.67	0	2.393	1.504	3.176	2.095	3.261	2.103	2.437	1.266	3.323	2.137

Item: 3

Cases for this item 650 Item-Rest Cor. 0.78 Item-Total Cor. 0.81

Item Threshold(s): -4.41 -0.53 1.08 3.02 Weighted MNSQ 1.14

Item Delta(s): -4.39 -0.36 1.02 2.89

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	31	4.77	-0.28	-7.46	0.000	-2.880	1.319	-3.788	1.887	-3.66	2.09	-2.643	1.421	-3.771	2.33
1	226	34.77	-0.62	-20.26	0	-1.683	1.353	-2.292	1.952	-2.351	2.194	-1.467	1.282	-2.289	2.255
2	179	27.54	0.13	3.32	0.001	0.367	1.007	0.544	1.389	0.639	1.674	0.393	1.222	0.661	1.67
3	150	23.08	0.41	11.35	0	1.412	0.988	1.935	1.339	1.926	1.604	1.183	1.157	1.929	1.615
4	64	9.85	0.43	12	0	2.783	1.284	3.744	1.8	3.644	2.05	2.351	1.438	3.596	2.267

Item: 4

Cases for this item 650 Item-Rest Cor. 0.83 Item-Total Cor. 0.86

Item Threshold(s): -3.25 -1.11 0.32 2.84 Weighted MNSQ 0.84

Item Delta(s): -3.15 -0.98 0.15 2.77

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	62	9.54	-0.44	-12.35	0.000	-2.901	1.358	-3.963	1.940	-4.226	1.948	-2.654	1.134	-4.24	2.03
1	141	21.69	-0.51	-14.96	0	-1.854	1.077	-2.535	1.511	-2.59	1.732	-1.607	1.123	-2.548	1.818
2	154	23.69	-0.06	-1.44	0.151	-0.183	1.022	-0.192	1.462	-0.154	1.727	-0.205	1.188	-0.101	1.764
3	214	32.92	0.44	12.48	0	1.127	1.024	1.583	1.41	1.714	1.6	1.061	1.148	1.698	1.631
4	79	12.15	0.47	13.62	0	2.712	1.063	3.614	1.479	3.492	1.609	2.285	1.176	3.516	1.684

Item: 5

Cases for this item 650 Item-Rest Cor. 0.82 Item-Total Cor. 0.84

Item Threshold(s): -2.75 -0.73 2.89 Weighted MNSQ 0.96

Item Delta(s): -2.61 -0.84 2.87

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	123	18.92	-0.61	-19.81	0.000	-2.651	1.181	-3.671	1.668	-3.823	1.856	-2.285	1.129	-3.814	1.937
1	139	21.38	-0.31	-8.21	0	-1.062	1.068	-1.438	1.468	-1.469	1.691	-0.973	1.195	-1.444	1.708
2	271	41.69	0.32	8.58	0	0.686	1.114	0.977	1.45	1.078	1.647	0.659	1.299	1.109	1.668
3	117	18	0.54	16.5	0	2.338	1.169	3.235	1.583	3.195	1.738	1.902	1.302	3.186	1.841

Item: 6

Cases for this item 650 Item-Rest Cor. 0.81 Item-Total Cor. 0.83

Item Threshold(s): -4.83 -0.56 3.55 Weighted MNSQ 0.85

Item Delta(s): -4.82 -0.55 3.53

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	48	7.38	-0.44	-12.4	0.000	-3.463	1.014	-4.849	1.337	-4.913	1.525	-2.934	1.062	-5.036	1.593
1	225	34.62	-0.54	-16.24	0	-1.41	1.142	-1.899	1.618	-1.951	1.911	-1.238	1.228	-1.858	1.962
2	293	45.08	0.42	11.69	0	0.848	1.071	1.198	1.409	1.26	1.635	0.763	1.26	1.269	1.66
3	84	12.92	0.49	14.12	0	2.63	1.199	3.581	1.685	3.54	1.784	2.151	1.338	3.469	2.027

Item: 7

Cases for this item 650 Item-Rest Cor. 0.77 Item-Total Cor. 0.80

Item Threshold(s): -2.92 -0.74 2.68 Weighted MNSQ 1.15

Item Delta(s): -2.80 -0.83 2.65

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	115	17.69	-0.61	-19.5	0.000	-2.750	1.172	-3.886	1.578	-4.042	1.735	-2.248	1.238	-4.002	1.866
1	145	22.31	-0.27	-7.03	0	-1.005	1.127	-1.292	1.56	-1.191	1.858	-0.934	1.332	-1.126	1.958
2	261	40.15	0.31	8.39	0	0.689	1.101	1.017	1.467	1.144	1.752	0.606	1.278	1.161	1.76
3	129	19.85	0.48	13.74	0	2.079	1.419	2.796	1.922	2.562	2.154	1.711	1.491	2.51	2.269

Item: 8

Cases for this item 650 Item-Rest Cor. 0.84 Item-Total Cor. 0.86

Item Threshold(s): -3.96 -0.72 3.31 Weighted MNSQ 0.85

Item Delta(s): -3.92 -0.75 3.29

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	80	12.31	-0.53	-16.07	0.000	-2.982	1.185	-4.202	1.626	-4.505	1.707	-2.496	1.202	-4.473	1.802
1	184	28.31	-0.44	-12.3	0	-1.195	1.231	-1.631	1.655	-1.81	1.684	-1.236	1.21	-1.762	1.734
2	283	43.54	0.34	9.11	0	0.647	1.098	0.938	1.421	1.095	1.461	0.655	1.196	1.113	1.545
3	103	15.85	0.56	17.18	0	2.536	1.114	3.518	1.462	3.642	1.474	2.2	1.154	3.596	1.626

Item: 9

Cases for this item 650 Item-Rest Cor. 0.76 Item-Total Cor. 0.79

Item Threshold(s): -3.94 -0.44 2.65 Weighted MNSQ 1.18

Item Delta(s): -3.91 -0.42 2.61

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	75	11.54	-0.5	-14.72	0.000	-2.997	1.313	-4.229	1.808	-4.292	2.098	-2.452	1.361	-4.383	2.112
1	205	31.54	-0.37	-10.09	0	-1.059	1.278	-1.431	1.716	-1.448	1.94	-0.936	1.37	-1.391	2.009
2	241	37.08	0.24	6.38	0	0.595	1.13	0.862	1.479	0.912	1.743	0.527	1.317	0.967	1.718
3	129	19.85	0.54	16.17	0	2.204	1.332	3.059	1.788	3.028	1.952	1.811	1.433	2.979	2.043

Item: 10

Cases for this item 650 Item-Rest Cor. 0.85 Item-Total Cor. 0.87

Item Threshold(s): -2.37 -0.21 2.73 Weighted MNSQ 0.91

Item Delta(s): -2.26 -0.28 2.68

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	144	22.15	-0.64	-21.46	0.000	-2.453	1.222	-3.436	1.681	-3.642	1.749	-2.104	1.193	-3.575	1.901
1	156	24	-0.29	-7.65	0	-0.923	1.049	-1.259	1.39	-1.275	1.611	-0.871	1.231	-1.311	1.635
2	226	34.77	0.36	9.74	0	0.899	1.016	1.3	1.279	1.375	1.417	0.814	1.181	1.435	1.44
3	124	19.08	0.56	17.24	0	2.259	1.205	3.137	1.567	3.26	1.573	1.933	1.271	3.214	1.69

Item: 11

Cases for this item 650 Item-Rest Cor. 0.83 Item-Total Cor. 0.85

Item Threshold(s): -4.30 -0.94 2.12 Weighted MNSQ 0.88

Item Delta(s): -4.27 -0.93 2.08

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	68	10.46	-0.49	-14.21	0.000	-2.936	1.198	-4.210	1.627	-4.754	1.554	-2.472	1.096	-4.555	1.72
1	178	27.38	-0.48	-13.82	0	-1.426	1.232	-1.945	1.635	-2.059	1.563	-1.384	1.225	-2.07	1.742
2	232	35.69	0.17	4.29	0	0.379	1.123	0.559	1.428	0.669	1.413	0.397	1.212	0.69	1.516
3	172	26.46	0.64	21.21	0	2.043	1.218	2.876	1.582	3.059	1.612	1.787	1.307	3.032	1.662

Item: 12

Cases for this item 650 Item-Rest Cor. 0.82 Item-Total Cor. 0.84

Item Threshold(s): -3.75 0.56 3.61 Weighted MNSQ 0.89

Item Delta(s): -3.74 0.60 3.57

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	91	14	-0.52	-15.62	0.000	-2.693	1.353	-3.750	1.888	-4.15	1.835	-2.436	1.157	-4.084	2.044
1	265	40.77	-0.39	-10.77	0	-0.826	1.298	-1.119	1.755	-1.235	1.741	-0.835	1.258	-1.145	1.876
2	209	32.15	0.42	11.93	0	1.121	1.097	1.557	1.415	1.721	1.271	1.098	1.061	1.681	1.39
3	85	13.08	0.52	15.41	0	2.538	1.086	3.576	1.414	3.963	1.288	2.333	1.134	3.85	1.466

Item: 13

Cases for this item 650 Item-Rest Cor. 0.76 Item-Total Cor. 0.79

Item Threshold(s): -2.51 0.68 2.27 5.59 Weighted MNSQ 1.32

Item Delta(s): -2.48 0.86 2.08 5.56

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	148	22.77	-0.61	-19.81	0.000	-2.214	1.354	-3.152	1.853	-3.555	1.837	-1.934	1.183	-3.439	1.999
1	215	33.08	-0.16	-4.19	0	-0.433	1.444	-0.55	1.886	-0.606	1.757	-0.528	1.46	-0.56	1.929
2	131	20.15	0.25	6.57	0	0.941	1.284	1.313	1.649	1.369	1.611	0.815	1.289	1.353	1.682
3	132	20.31	0.45	12.97	0	1.686	1.312	2.396	1.708	2.754	1.502	1.64	1.208	2.662	1.588
4	24	3.69	0.27	7.15	0	2.535	1.367	3.675	1.844	4.379	1.604	2.556	1.305	4.338	1.835

Item: 14

Cases for this item 650 Item-Rest Cor. 0.75 Item-Total Cor. 0.78

Item Threshold(s): -3.74 0.26 2.24 Weighted MNSQ 0.84

Item Delta(s): -3.72 0.38 2.10

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	46	7.08	-0.33	-9.02	0.000	-2.402	1.444	-3.226	1.978	-3.578	2.002	-2.571	1.12	-3.523	2.042
1	297	45.69	-0.55	-16.86	0	-1.142	1.569	-1.549	2.212	-1.656	2.305	-1.121	1.31	-1.63	2.348
2	198	30.46	0.36	9.84	0	0.948	1.123	1.334	1.524	1.528	1.608	0.98	1.026	1.505	1.632
3	109	16.77	0.52	15.55	0	2.274	1.156	3.082	1.559	3.168	1.618	2.218	1.159	3.226	1.711

Item: 15

Cases for this item 650 Item-Rest Cor. 0.65 Item-Total Cor. 0.68

Item Threshold(s): -3.19 -0.20 2.89 Weighted MNSQ 1.07

Item Delta(s): -3.14 -0.21 2.85

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	64	9.85	-0.36	-9.73	0.000	-2.224	1.708	-2.994	2.319	-3.317	2.333	-2.404	1.486	-3.329	2.48
1	237	36.46	-0.41	-11.3	0	-1.047	1.579	-1.375	2.24	-1.47	2.355	-1.08	1.304	-1.436	2.364
2	273	42	0.35	9.44	0	0.751	1.447	1.029	2.026	1.097	2.098	0.754	1.236	1.11	2.108
3	76	11.69	0.41	11.28	0	2.253	1.421	3.003	1.961	3.325	1.896	2.483	1.119	3.337	2.03

Item: 16

Cases for this item 650 Item-Rest Cor. 0.79 Item-Total Cor. 0.81

Item Threshold(s): -5.19 -0.36 2.99 Weighted MNSQ 1.07

Item Delta(s): -5.19 -0.33 2.96

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	47	7.23	-0.42	-11.86	0.000	-3.231	1.193	-4.633	1.565	-5.016	1.683	-2.763	1.25	-5.14	1.611
1	238	36.62	-0.53	-15.77	0	-1.281	1.341	-1.746	1.82	-1.839	1.892	-1.238	1.244	-1.864	1.859
2	244	37.54	0.33	8.82	0	0.738	1.116	1.052	1.454	1.158	1.586	0.726	1.214	1.182	1.501
3	121	18.62	0.53	15.72	0	2.17	1.388	3.043	1.796	3.161	1.804	1.919	1.37	3.307	1.789

Item: 17

Cases for this item 650 Item-Rest Cor. 0.85 Item-Total Cor. 0.87

Item Threshold(s): -3.71 -1.09 2.47 4.92 Weighted MNSQ 0.88

Item Delta(s): -3.63 -1.14 2.53 4.83

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	92	14.15	-0.58	-18.18	0.000	-2.896	1.148	-4.109	1.551	-4.42	1.575	-2.525	1.061	-4.519	1.593
1	146	22.46	-0.38	-10.61	0	-1.249	1.167	-1.741	1.537	-1.917	1.543	-1.248	1.133	-1.963	1.407
2	257	39.54	0.22	5.74	0	0.512	1.133	0.758	1.433	0.79	1.414	0.435	1.176	0.8	1.313
3	118	18.15	0.43	12.2	0	1.594	1.309	2.286	1.662	2.607	1.592	1.562	1.263	2.748	1.436
4	37	5.69	0.38	10.6	0	3.115	1.022	4.307	1.364	4.528	1.393	2.796	1.185	4.753	1.4

Item: 18

Cases for this item 650 Item-Rest Cor. 0.76 Item-Total Cor. 0.79

Item Threshold(s): -2.30 2.04 4.41 Weighted MNSQ 1.12

Item Delta(s): -2.29 2.13 4.31

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	164	25.23	-0.67	-22.94	0.000	-2.208	1.409	-3.118	1.940	-3.434	1.949	-2.03	1.24	-3.443	2.018
1	300	46.15	0.05	1.15	0.249	0.1	1.44	0.184	1.915	0.191	1.929	-0.002	1.336	0.144	1.853
2	134	20.62	0.39	10.93	0	1.35	1.107	1.909	1.379	2.168	1.376	1.363	1.149	2.245	1.215
3	52	8	0.4	11.12	0	2.639	1.361	3.69	1.77	3.983	1.548	2.609	1.264	4.31	1.567

Item: 19

Cases for this item 650 Item-Rest Cor. 0.82 Item-Total Cor. 0.84

Item Threshold(s): -1.82 0.28 2.68 4.93 Weighted MNSQ 1.06

Item Delta(s): -1.70 0.23 2.70 4.82

Label & Score	Count	% of tot	Pt Bis	t	sig	PV1Avg: 1	PV1 SD:1	PV1Avg: 2	PV1 SD:2	PV1Avg: 3	PV1 SD:3	PV1Avg: 4	PV1 SD:4	PV1Avg: 5	PV1 SD:5
0	184	28.31	-0.72	-26.33	0.000	-2.179	1.322	-3.097	1.782	-3.364	1.8	-2.017	1.196	-3.488	1.742
1	149	22.92	-0.08	-1.94	0.053	-0.234	1.228	-0.281	1.566	-0.316	1.6	-0.283	1.18	-0.361	1.392
2	180	27.69	0.28	7.4	0	0.799	1.183	1.16	1.476	1.299	1.48	0.769	1.22	1.375	1.299
3	101	15.54	0.43	12.04	0	1.8	1.359	2.543	1.788	2.752	1.763	1.758	1.273	3	1.611
4	36	5.54	0.33	8.97	0	2.674	1.195	3.827	1.424	4.052	1.445	2.277	1.288	4.124	1.519

The following traditional statistics are only meaningful for complete designs and when the amount of missing data is minimal.
In this analysis 0.00% of the data are missing.

The following results are scaled to assume that a single response was provided for each item.

N	650
Mean	30.99
Standard Deviation	15.02
Variance	225.67
Skewness	-0.06
Kurtosis	-0.94
Standard error of mean	0.59
Standard error of measurement	2.65
Coefficient Alpha	0.97

Appendix J. Study 2: Recruitment and Permission Documents**J1: Call for Participants for Delphi Survey**

– Call for experienced paediatric occupational therapy specialists –

Standard-setting to measure growth in movement problem-solving capability for students with additional physical needs: A Delphi survey

A doctoral researcher and occupational therapist from the Melbourne Graduate School of Education, University of Melbourne, is seeking paediatric occupational therapists experienced in working with children with motor difficulties, to participate in setting standards for a new motor skills learning progression. It is envisaged the resulting reporting form will enable general classroom teachers to accurately record and communicate their knowledge of a student's motor capacities to other members of the learning support team, including occupational therapists.

Participation will be anonymous and involve 3-4 rounds of input (each taking approximately 1-1½ hours), across October-November 2016.

This research will contribute to collaborative partnerships between teachers and occupational therapists and support the motor learning and physical classroom participation of students with a wide range of movement difficulties.

If interested, please contact by Wednesday 28th September to –

Lindsey Gale

W:

Email:

J2: Delphi Standard-setting Survey – Plain Language Statement**Standard-setting to measure growth in movement problem-solving capability for students with additional physical needs: A Delphi survey with experienced paediatric occupational therapists**

We invite you to participate in research being conducted under the supervision of Associate Professor Shelley Gillis and Dr Kerry Woods, of the Melbourne Graduate School of Education, University of Melbourne. This research is part of doctoral study being undertaken by Lindsey Gale, and has been approved by the Human Research Ethics Committee of the University of Melbourne.

What are the aims of the research?

In 2015, a set of rubrics was developed, to assist general classroom teachers to record the classroom-based motor proficiency of students with physical disabilities. Teachers then used this rubric to assess the motor skill of over 2,300 students. The returned data was analysed, revealing a clear learning progression for motor skill acquisition. The rubrics have been designed to provide teachers with a standardised recording and reporting tool to communicate their extensive knowledge of a student's motor capacities against the developmental learning progression to other members of the learning support team, including occupational therapists.

This follow-up study aims to further refine the set of rubrics and the motor skill learning progression by engaging experienced occupational therapists on interpretation and standard-setting. In addition to the standard setting process, we are seeking feedback from experienced occupational therapists on the usefulness of the rubrics and learning progression to aid communication and collaborative planning with other members of the learning team, such as teachers.

What will you be asked to do?

Should you agree to participate, you will be provided with the set of rubrics and associated learning progression, and across September and October 2016, engage in a 'Delphi' process to achieve consensus on four related tasks:

- (1) establishing where to 'cut' the progression to produce performance levels
- (2) determining the performance level descriptions (i.e. summary statements of the typical skills and knowledge that underpin each level of performance)
- (3) determining important gaps in the progression, and identifying skills to fill these
- (4) determining the optimal reporting format of the tool to guide communication and collaborative planning.

HREC: Project No 1543899.1; **Date:** 30/08/17; **Version:** Delphi panellist

Centre for Vocational and Educational Policy (CVEP)

The University of Melbourne Victoria 3010 Australia

T: +61 8344 8529 **W:** www.edfacunimelb.edu.au

A Delphi survey seeks the anonymous judgements of people with experience in a given area, about issues requiring consensus opinion. It uses an electronic rather than face to face consultation to allow individuals to provide their judgement anonymously, and further opportunity to revise their judgements after considering the anonymous feedback of others. The judgements are processed through a series of iterative rounds, with controlled feedback given between rounds.

If you agree to voluntarily participate in the Delphi survey, you will be requested to complete an online survey, at a time and places convenient to you. Each round is expected to take approximately one to one and a half hours. You will be sent the work for each round via Survey Monkey link and will have a week to complete your response. Each subsequent round will begin with feedback summarising responses from the prior round, and invitation to accept/reject changes or refine judgements, with a view to reaching consensus. The process will not continue beyond four rounds.

How will confidentiality be protected?

Participation in the Delphi survey is completely voluntary, and the anonymity and confidentiality of all data and your responses will be ensured throughout the data collection process. The findings of the study will be reported at the aggregate level and no individual participant will be identified in any publications or reports that arise from this study.

Should you wish to withdraw from the study at any time, or to withdraw unprocessed information that has been collected, you are completely free to do so. All information will be treated in the strictest confidence subject to any legal limitations. It will be stored in secured files at the University of Melbourne under the University's guidelines for the management of research data and records and destroyed five years after publication of written findings.

How will you receive feedback?

On completion of the research, a summary of findings will be made available to you. However, neither you nor any other participant will be identified in the summary findings. Hence, confidentiality will be assured to the fullest possible extent. In addition to the findings being presented within a doctoral thesis, it is expected that the results will also be disseminated through research journals and presented at educational and occupational therapy conferences.

How do you agree to participate?

If you would like to participate, please indicate that you have read and understood this information by signing the accompanying consent form and returning it to Lindsey Gale by mail, or in scanned format to the following postal or email address: Lindsey Gale, Centre for Vocational and Educational Policy (CVEP), Melbourne Graduate School of Education, University of Melbourne, 100 Leicester Street, Carlton VIC 3010;
l.gale@student.unimelb.edu.au

HREC: Project No 1543899.1; **Date:** 30/08/17; **Version:** Delphi panellist

Centre for Vocational and Educational Policy (CVEP), Melbourne Graduate School of Education
The University of Melbourne Victoria 3010 Australia
T: +61 8344 8529 **W:** www.edfacunimelb.edu.au

Should you require any further information or have any concerns, please do not hesitate to contact me by email, or on 9035 4780.

This research is conducted with the clearance of the Human Research Ethics Committee (HREC), University of Melbourne. If you have any concerns regarding the conduct of the research, which you do not wish to discuss with the research team, you are welcome to contact the Manager, Human Research Ethics, University of Melbourne, VIC 3010. Tel: (03) 8344 2073).

Thank you for giving some of your time to reading this statement and considering its contents.

Yours sincerely,



Mrs Lindsey Gale
Melbourne Graduate School of Education
The University of Melbourne



Associate Professor Shelley Gillis
Melbourne Graduate School of Education
The University of Melbourne



Dr Kerry Woods
Melbourne Graduate School of Education
The University of Melbourne

HREC: Project No 1543899.1; **Date:** 30/08/17; **Version:** Delphi panellist

J3: Delphi Standard-Setting Study – Consent Form

Standard-setting to measure growth in movement problem-solving capability for students with additional physical needs: A Delphi survey with experienced paediatric occupational therapists

Name:

Current role:

Names of Investigators: Associate Professor Shelley Gillis; Dr Kerry Woods; Lindsey Gale

I consent to participate in the above research. I understand the nature of the research and what is expected of me, and I agree to take part on that basis.

I acknowledge that:

- I have received a copy of and read the Plain Language Statement explaining the study;
- I have received an adequate explanation of all likely risks, effects, discomforts or inconvenience arising from participation in the project;
- I understand my participation is voluntary, that I have the right to withdraw at any time, and that I may withdraw any data supplied up to the point of analysis and publication;
- I understand that I will not be video-taped, audio-taped, or photographed;
- I have been informed that the confidentiality of the information I provide will be safeguarded, subject to any legal requirements (e.g., subpoena, freedom of information, mandated reporting), and in the following ways:
 - no names or personal details of individual participants will be revealed in any report of the study, and any contextual details that might reveal identity will be removed;
 - only the investigators will have access to the data collected in this study; and
 - data will be stored securely in a locked facility in the Assessment Research Centre, Melbourne Graduate School of Education, and destroyed five years after the completion of the written findings of the research.

Signature: **Date:**

HREC: Project No 1543899.1; **Date:** 30/08/17; **Version:** Delphi panellist

Centre for Vocational and Educational Policy (CVEP)

The University of Melbourne Victoria 3010 Australia

T: +61 8344 8529 **W:** www.edfacunimelb.edu.au

Appendix K. Study 2: Ethics Approval Documentation

30 August 2016

A/Prof Shelley Gillis
Melbourne Graduate School of Education
The University of Melbourne

Dear A/Prof Gillis,

Project title: Standard-setting to measure growth in movement problem-solving capability for students with additional physical needs: A Delphi survey with experienced paediatric occupational therapists.
Researchers: Shelley Gillis, Lindsay Gale and Kerry Woods.
Ethics ID/HREC: 1543899
MGSE HEAG ID: 102/16

I am pleased to advise that the Request for Amendment to this Project was approved by the Melbourne Graduate School of Education Human Ethics Advisory Group (MGSE HEAG) on 30 August 2016.

Please note it is your responsibility to ensure that all people associated with the Project are made aware of the amendment.

If you have any queries or require additional information, please contact me using the details below.

Please quote the ethics registration number and title of the Project in any future correspondence.

Yours sincerely

Associate Professor Dianne Vella-Brodrick
Chairperson, Melbourne Graduate School of Education Human Ethics Advisory Group
Phone: 83440254, Email: dianne.vella-brodrick@unimelb.edu.au

cc: Lindsay Gale, Kerry Woods and Human Research Ethics Committee (HREC), The Office for Research Ethics and Integrity.



University of Melbourne
Human Research Ethics Committee
Victoria 3010
Australia

22 August 2016

To whom it may concern,

Re: research project - "Standard-setting to measure growth in movement problem-solving capability for students with additional physical needs: A Delphi survey with experienced paediatric occupational therapists."

This letter is to confirm support from the Victorian Division of Occupational Therapy Australia to recruit participants for the abovementioned study being conducted under the leadership of Associate Professor Shelley Gillis, of the Centre for Vocational and Educational Policy, Melbourne Graduate School of Education at the University of Melbourne.

I understand that the study seeks to recruit experienced paediatric occupational therapists to set standards for a movement problem-solving assessment framework, developed in the first part of this research. I am supportive of the intention of the research to contribute towards collaborative partnerships between teachers and occupational therapists, to support student learning and participation.

I have been provided with a copy of the research Plain Language Statement and Consent form, a sample advertisement for the OTA Vic Division e-bulletin, and a draft outline of the Delphi process.

Following conformation of ethics approval for this research, I agree to include this call for research participants in our Victorian member e-bulletins.

Kind regards,

A handwritten signature in black ink, appearing to read "K. Mestroni", written in a cursive style.

Kim Mestroni
Victoria Division Manager
Occupational Therapy Australia



Appendix L. Study 2: Delphi Panellist Demographic Questions

1) In what areas of paediatric practice have you been engaged? (check all that apply)

- ☐ School settings
 - ☐ Hospital setting
 - ☐ Community health
 - ☐ Non-government organisation
 - ☐ Private practice/ consultancy
 - ☐ Other (give details as relevant)
-

2) What is the nature of your experience and involvement in supporting students with physical disabilities or movement difficulties? (check all that apply)

- ☐ Working with students (in or out of the classroom) on movement related concerns
 - ☐ Consulting/collaborating with teachers or teaching assistants
 - ☐ Teaching, research and/or writing in this area
 - ☐ Involvement in relevant organisations/ networks/ special interest groups
 - ☐ Other (give details as relevant)
-

Appendix M. Study 2: Delphi Materials

M1: Delphi Round 1 – Correspondence

A Delphi standard-setting study to measure growth in movement problem-solving for students with movement difficulties

Dear

Welcome to Round 1 of this Delphi standard-setting study, designed to assist measurement of motor learning ability in students with movement difficulties. This round begins today (Monday 3rd October), and will conclude on Wednesday 12th October, when your responses need to be submitted. Collation of responses will then take place, before Round 2 commences on Monday 17th October. It is envisaged each round will take 1-1.5 hours to complete.

This email provides you with background information on the motor learning rubrics you will be working with, and the Delphi process we will be following. These rubrics were developed to assist classroom teachers to communicate their knowledge of the movement capacities of students with a wide range of movement difficulties. When standardised, these rubrics will support interpretation, intervention planning and monitoring of progress by all members of student learning support teams.

Explaining rubrics

Rubrics are guidelines for rating performance quality in a learning area, enabling assessors to discriminate between higher and lower quality responses (Griffin, 2014). Rubrics express behaviours unique to a learning area in terms of the different amounts of underlying trait required for their successful performance. A single rubric consists of an observable behaviour and a set of statements describing that behaviour at different levels of competency or attainment. This set of rubrics were developed according to guidelines for the educational measurement of unidimensional latent constructs (Wilson, 2005; Wright & Masters, 1982).

Latent constructs are abilities or attributes (for example, 'dexterity' or 'language ability'), that are not directly observable, but can be inferred from observation of performance on tasks designed to elicit those traits. This concept of latency is relevant to the movement learning domain, as Carr & Shepherd (2006) note: "Motor learning itself cannot be directly observed... only inferred from a relatively consistent improvement in performance" (p.151).

There are an extensive number of skills that could be listed for this learning domain, however, what is required is a representative, cohesive sample of important skills that are teachable in the classroom (Griffin, 2014). In relation to classroom-based motor learning, 19 skills were identified.

Additionally, many levels of performance could be provided for progression of skill in these rubrics, however, a selection that enables accurate pinpointing of ability level for the cohort in question is sufficient. Three or four clearly differentiated proficiency levels were therefore identified for each of these 19 skills, resulting in 63 unique performance descriptions.

Explaining Delphi surveys

Delphi surveys support decision-making and consensus among experts. Delphi methodology

recognises that group opinion is more valid than individual opinion, but that face-to-face groups can be impacted by dominant personalities and group pressure, and that gathering experts together for face-to-face meetings, particularly on multiple occasions, is logistically difficult. Therefore, the methodology involves panellists operating separately and anonymously, linked through the researcher, who receives, summarises and feeds back the group's responses to each panellist individually.

Delphi surveys take place in stages, where each stage builds on results from the previous stage/s. The first stage and round elicits opinions and ideas in an open-ended manner, and subsequent rounds respond to, extend and rank opinions until consensus is reached (on some or all items as required).

This e-Delphi follows a classic consensus design in relation to setting standards for a classroom measure of motor learning, and a non-consensus argument design in relation to identifying formats for reporting results ((Keeney, Hasson & McKenna, 2011).

Procedure

The survey will entail three work rounds, with a concluding feedback round providing optional opportunity for final reflections and/or suggestions -

Round 1 – An initial questionnaire in the first round for panellist demographic information, followed by categorisation of skills into the main motor-learning proficiency areas;

Round 2 – Finalising agreement on the motor-learning proficiency areas and setting standards for each area (identifying cut points and providing suggestions for level descriptors);

Round 3 – Finalising agreement on standard-setting, and key perspectives on optimal reporting format for results;

Round 4 (optional) – Final response summary and conclusions; opportunity for further comments/ suggestions.

I will send a reminder email on Monday 10th October, to support timely completion of your responses for this round. At any time, please don't hesitate to contact me with questions or concerns.

Thank you for your participation in this important work!

Lindsey Gale | PhD candidate
Assessment Research Centre | Melbourne Graduate School of Education
Level 8, 100 Leicester Street
The University of Melbourne, Victoria 3010 Australia

[Begin Survey](#)

M2: Delphi Round 1 – Working Categories for the Construct

In consultation with a group of expert special educators, the following 19 movement skills were nominated as important and teachable in the classroom/ school context:

1. Maintaining balance and upright posture
2. Regulating physical tension
3. Coordinating response to sensory input
4. Positioning self to engage in activity
5. Remembering a movement sequence or strategy
6. Moving from one position or place to another
7. Using movement skills to avoid obstacles or prevent problems occurring
8. Obtaining objects
9. Transporting objects from place to place
10. Managing personal school equipment (bags, books, lunch, clothing)
11. Using sporting or activity equipment (mats, balls, climbing equipment, musical instruments)
12. Manipulating and using classroom-related tools and materials (scissors, ruler, keyboard/mouse)
13. Using writing and drawing implements
14. Sharing space interactively with others
15. Using movement for self-expression and communication
16. Seeking out movement experiences and challenges
17. Persevering in movement tasks or activities
18. Working within physical limits
19. Completing tasks involving strenuous movement

While these items pertain to a single motor skill dimension, identifying sub-categories assists interpretation of results and targeted intervention, as it provides more detail of student strengths and learning needs. On examination of some standard tools and categorisations, five areas emerge as common –

	Balance, postural control	Transport of self and objects	Manipulation and use of tools	Communicative/ interactive skills	Performance sustainment
Castañer et al, 2009; Gallahue & Donnelly, 2003; Newell, 1991	stability	locomotion	manipulation		
Reed, 1982	orienting, investigatory	locomotor	performatory	expressive	play
Gentile (1987)	maintaining or changing body position;	body coordination	maintaining or changing object position		
BOT-2			fine manual control	manual coordination	strength/agility
Coster et al, 1998	maintaining and changing positions,	travel; up/down stairs; manipulation while moving	using materials; setup/clean-up; written work; computer use		
Wright & Majnemer, 2014	walking and moving		fine hand use	communicating	physical endurance

- the commonly used stability, locomotion and manipulation dimensions (Castañer et al, 2009; Gallahue & Donnelly, 2003; Newell, 1991);
- Gentile's extensively used categorisation of movement goals as either maintaining or changing body position, maintaining or changing the position of objects, or both (Gentile, 1987, p.94-5).
- the Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition (BOT-2) dimensions of fine manual control, manual coordination, body coordination and strength/ agility;
- the twelve subsections of Coster et al's (1998, pp.21-2) School Function Assessment, including travel, maintaining and changing positions, manipulation with movement, using materials, setup/clean-up, up/down stairs, written work and computer use (Coster et al, 1998, p.21-2);
- Wright and Majnemer's (2014) use of the International Classification of Functioning and Health (ICF), to identify a four-fold categorisation of the physical functioning of individuals with cerebral palsy – walking and moving, communicating, fine hand use and general physical endurance.
- Reed's (1982) action systems – orienting, investigatory, locomotor, performatory, expressive, play

In light of these categorisations and movement skills, the following five categories are proposed:

- Balance, postural control and positioning;
- Transportation of self and objects;
- Manipulation and use of school-related objects, tools and equipment;
- Self-regulation, self-expression and social interaction;
- Fitness, endurance and motivation.

Place the 19 skills as you feel they best fit into these five categories.

Provision has been made for you to choose more than one category if you are undecided about the single placement of a skill. Use the questions following this task to give your reasoning, including issues encountered, concerns about categories/labelling, and possible alternatives or other suggestions.

	Balance, postural control, and positioning	Transport of self and objects	Manipulation and use of school- related objects & tools	Communicati ve/ interactive skills	Performance sustainment
Completing tasks involving strenuous movement	☐	☐	☐	☐	☐
Coordinating response to sensory input	☐	☐	☐	☐	☐
Maintaining balance and upright posture	☐	☐	☐	☐	☐
Managing personal school equipment (bags, books)	☐	☐	☐	☐	☐

Using classroom-related tools (scissors, ruler, etc.)	☐	☐	☐	☐	☐
Moving from one position or place to another	☐	☐	☐	☐	☐
Obtaining objects	☐	☐	☐	☐	☐
Persevering in movement tasks or activities	☐	☐	☐	☐	☐
Positioning self to engage in activity	☐	☐	☐	☐	☐
Regulating physical tension	☐	☐	☐	☐	☐
Remembering a movement sequence or strategy	☐	☐	☐	☐	☐
Seeking out movement experiences and challenges	☐	☐	☐	☐	☐
Sharing space interactively with others	☐	☐	☐	☐	☐
Transporting objects from place to place	☐	☐	☐	☐	☐
Using movement for expression, communication	☐	☐	☐	☐	☐
Using movement to avoid obstacles, prevent problems occurring	☐	☐	☐	☐	☐
Using sporting or activity equipment (mats, balls, bikes, music instruments)	☐	☐	☐	☐	☐
Using writing and drawing implements	☐	☐	☐	☐	☐
Working within physical limits	☐	☐	☐	☐	☐

Please provide your thinking in relation to the following areas:

Placement of skills into categories: Were any skills difficult to place, and if so, why?

Use of multiple categories: Did you place any skills in more than one category, and why?

Reporting format: Are these useful categories for reporting, or can you suggest others?

Other comments/suggestions:

M3: Delphi Round 2 – Instructions for Standard Setting

As previously explained, the initial development of these rubrics involved expert special educators identifying 3-4 quality indicators for each of the 19 skills. This resulted in 63 unique indicators which have now been placed into the categories nominated by the work of Round 1 of this Delphi survey, including Item 8's indicators being included in the two categories identified by the panel as equally appropriate for that skill.

Standard-setting involves completing the following 4 tasks for each of the 5 categories –

1. Note the order of skills in each category, commenting on any that seem to you to be wrongly placed;
2. Divide the continuum where there are more significant 'jumps' or qualitative 'shifts' in the nature or sophistication of the skill
NOTE: Provide as many levels as you feel are relevant to each category – the number can vary;
3. Having divided the progression, provide a brief summary of the nature of the skills operating at each level
NOTE: Draw on your professional knowledge to assist you to describe each level; dot point summary is fine;
4. Having summarised the levels of progression, indicate any gaps or important missing skills, and provide suggestions to fill these
NOTE: This step is optional. Only important, observable and teachable skills that fill significant gaps should be added.

To illustrate these tasks, a set of Functional Communication skills (adapted from Woods, 2010) have been standardised below –

1. Ordered ranking of Functional Communication indicators:

Rank	Functional Communication
9 (hardest)	<i>Describes the emotion displayed by another</i>
8	<i>Acknowledges/ answers a person who communicates with him/her</i>
7	<i>Shares another's focus of attention</i>
6	<i>Uses names, signs &/or symbols to acknowledge receipt of object</i>
5	<i>Reacts to others' displays of emotion</i>
4	<i>Pays attention to person who is communicating with him/her</i>
3	<i>Responds to own name</i>
2	<i>Sustains eye contact, even if briefly</i>
1 (easiest)	<i>Reacts to environmental stimulus reflexively</i>

2. Dividing the continuum where there are larger 'leaps' or qualitative 'shifts' in the development of the skill:

Rank	Functional Communication
9 (hardest)	<i>Describes the emotion displayed by another</i>
8	<i>Acknowledges & answers person who communicates with him/her</i>
7	<i>Shares another's focus of attention</i>
6	<i>Uses names, signs &/or symbols to acknowledge receipt of object</i>
5	<i>Reacts to others' displays of emotion</i>
4	<i>Pays attention to person who is communicating with him/her</i>
3	<i>Responds to own name</i>
2	<i>Sustains eye contact, even if briefly</i>
1 (easiest)	<i>Reacts to environmental stimulus reflexively</i>

3. Providing a brief summary of the nature of the skills operating at each level:

Rank	Category – Functional Communication	Level description
9	<i>Describes the emotion displayed by another</i>	- recognises basic social rules - explores ways to convey information to others
8	<i>Acknowledges & answers person who communicates with him/her</i>	
7	<i>Shares another's focus of attention</i>	- learning to use symbols and words to express basic needs, wants and feelings
6	<i>Uses names, signs &/or symbols to acknowledge receipt of object</i>	
5	<i>Reacts to others' displays of emotion</i>	- learning to actively respond to communication by paying or withdrawing attention
4	<i>Pays attention to person who is communicating with him/her</i>	
3	<i>Responds to own name</i>	- developing ability to receive and respond to communication
2	<i>Sustains eye contact, even if briefly</i>	
1	<i>Reacts to environmental stimulus reflexively</i>	

4. Indicating any important gaps in this progression, and suggesting indicators to fill these:

Rank	Category – Functional Communication	Level description
9 (hardest)	<i>Describes the emotion displayed by another</i>	- learning to recognise some basic social rules - exploring ways to convey information to others
8	<i>Acknowledges & answers person who communicates with him/her</i>	
NEW	<i>Uses a particular name or form of greeting to acknowledge a particular person</i>	- learning to use symbols and words to express basic needs, wants and feelings
7	<i>Shares another's focus of attention</i>	
6	<i>Uses names, signs &/or symbols to acknowledge receipt of object</i>	
5	<i>Reacts to others' displays of emotion</i>	- learning to actively respond by paying or withdrawing attention
4	<i>Pays attention to communication partner</i>	
NEW	<i>Looks at an object introduced by another</i>	
3	<i>Responds to own name</i>	- developing ability to receive and respond to communication
2	<i>Sustains eye contact, even if briefly</i>	
NEW	<i>Acknowledges a person with facial expression, eye contact, vocalisations and/or gesture</i>	
1 (easiest)	<i>Reacts to environmental stimulus reflexively</i>	

M4. Delphi Round 2 – Dimensional Tables for Standard Setting

For each of the following five tables, complete these steps –

1. Rank the quality indicators in order of difficulty – easiest to hardest, beginning at the bottom of the table with #1 for the easiest skill
NOTE: Give items the same number if you believe them to be at the same difficulty level
2. Once ranked, indicate any gaps or important missing skills, and provide suggestions to fill these
NOTE: This is optional; only important, observable and teachable skills that fill significant gaps should be added.
3. With the skill progressions complete to your satisfaction, divide each into bands or levels, indicating ‘jumps’ or qualitative ‘shifts’ in the nature or sophistication of the skill
NOTE: Provide as many levels as you feel are relevant to each category – the number can vary
4. Having divided the progression, provide a summary of the nature of the skills operating at each level
NOTE: Draw on your professional knowledge to assist you to describe each level; dot point summary is fine

Rank order	1. BALANCE, POSTURAL CONTROL AND POSITIONING*	Level summaries
	#1 – Maintaining balance and upright posture;	
	#4 – Positioning self to engage in activity	
	Anticipates and adjusts position throughout activity to support efficient functioning	
	Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)	
	Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)	
	Positions self to commence activity (e.g., moves into position to enable use of objects/ tools)	
	Relies on strategies or cues to maintain stable posture (e.g., “feet flat, bottom back to sit up straight”)	
	Assists in being positioned for activity engagement (e.g., leans/ moves in)	
	Responds to activity when positioned in front of it (e.g., shows interest; attempts to reach)	
	Reacts to lost balance (e.g., startles; rights head; extends arms)	

Rank order	2. TRANSPORTATION OF SELF AND OBJECTS	Level summaries
#6 –	Moving from one position/ place to another	
#7 –	Using movement skills to avoid obstacles or prevent problems occurring	
#9 –	Obtaining objects	
#10 –	Transporting objects from place to place	
	Masters fluency and control when moving or repositioning quickly (e.g., changes direction smoothly in response to demands of a game; negotiates crowded hallways without difficulty)	
	Transports objects even while engaged on other aspects of activity (e.g., while manipulating objects; while talking; in crowded situations)	
	Modifies movement to avoid obstacles that have proved difficult in the past, or that have suddenly arisen (e.g., slows to avoid a trip hazard)	
	Adapts or adjusts strategies for obtaining objects to suit changing requirements or prevent problems (e.g., alters grip to secure object from falling; retrieves object from table while moving past it)	
	Concentrates to achieve transport of self and object(s)	
	Varies strategies for obtaining objects (e.g., one-handed or two-handed methods)	
	Focuses, or attends consciously, to reposition self during routine tasks (e.g., attends consciously to placement of feet; focuses on the movement requirements of the next step of task)	
	Attempts to avoid obstacles in familiar settings (e.g., gives wide berth; stops to wait for another to pass)	
	Cooperates in tasks involving transport of routine items	
	Reacts when moved around obstacles and through narrow spaces (e.g., holds on; leans in)	
	Uses a familiar strategy or method for obtaining objects (e.g., the same raking or swiping strategy for bringing all objects to self)	
	Shows awareness of being re-positioned or moved (e.g., orients or turns toward direction of travel; reaches to touch surfaces/objects while passing)	

Rank order	3. MANIPULATION AND USE OF OBJECTS, TOOLS AND EQUIPMENT	Level summaries
	#5 – Remembering a movement sequence or strategy #8 – Using sporting or activity equipment (mats, balls, bikes, musical instruments) #11 – Managing personal school equipment (bags, books, lunch, clothing) #12 – Manipulating and using classroom-related tools and materials #13 – Using writing and drawing implements	
	Maintains legible and fluent handwriting in demanding or novel writing tasks (e.g., when writing at speed or for long periods; when writing with different sizes/ types of writing implements)	
	Manipulates and uses tools and materials with appropriate strength and control, while attending to other aspects of task (e.g., moves and stabilises paper while writing; releases object accurately while attending to next step of task)	
	Adjusts movement response to meet requirements of equipment or activity (e.g., changes movement to keep time with musical rhythms; moves faster in attempt to reach ball)	
	Adapts a movement sequence to suit new circumstances (e.g., changes strategy to reach accurately at different speeds; alters gait quickly in response to suddenly changed conditions; combines sequences/ strategies to achieve more of a task)	
	Achieves legible handwriting when writing slowly in familiar writing tasks (e.g., writing own name; reproducing letters and numbers)	
	Uses a range of movement strategies to manage personal school equipment (e.g., uses different body parts to stabilise objects; different ways to grip and open lunchbox)	
	Copies or traces over patterns and shapes	
	Focuses or slows to use tools and materials with appropriate strength and control (e.g., concentrates to operate joystick; slows to use mouse; focuses to hold pen/ pencil lightly)	
	Repeats a simple movement sequence in imitation or from memory (e.g., to sit up straight; walk in walker; remove/put on jumper)	
	Uses equipment in familiar activities (e.g., passes items to a partner in a routine task)	
	Achieves component of equipment handling (e.g., holds backpack for another to close)	
	Cooperates with the next step of a routine movement (e.g. turns towards; lifts arms)	
	Scribbles, or makes marks on the paper	
	Responds to sensory properties of tools and materials (e.g. tightens and loosens grip, moves fingers over surface)	
	Attends to properties or functions of equipment (e.g., responds upon touching)	
	Attends to equipment when placed in hand or nearby (e.g. stills body; holds briefly)	

Rank order	4. SELF-REGULATION, SELF-EXPRESSION, SOCIAL INTERACTION #2 – Regulating physical tension/ managing physical behaviour & response #3 – Coordinating response to sensory input #14 – Sharing space interactively #15 – Using movement for self-expression & communication	Level summaries
		Adapts or adjusts movement in response to changing sensory input (e.g., immediately tightens hold on unexpectedly heavy object to prevent it from falling; successfully catches a ball thrown at a suddenly faster speed)
		Regulates physical tension and response during activities with changing energy demands (e.g., calms for quiet activity following activity with raised energy)
		Extends and adapts repertoire of gestures/ facial expressions to suit different needs or audiences (e.g., catches a person's eye and then directs their gaze; exaggerates or alters gestures or facial expressions to imitate others or to convey more nuanced meanings)
		Cooperates with others to share the space (e.g., moves responsively; moves over to share desk space)
		Practices moving under different sensory conditions (e.g. in time to a rhythm, in reduced light, at different speeds, or across different surfaces)
		Uses a strategy to manage physical tension during activity (e.g., requests a break; calms by linking breathing to a slow, repetitive movement)
		Manages own needs in shared space (e.g., follows instructions for avoiding bumping into others; experiments with how much room is needed to pass by another safely)
		Uses a consistent repertoire of gestures/ facial expressions to establish meaning
		Focuses on the sensory aspects of movement to achieve routine movement tasks (e.g., watches hands to reach accurately; attends to positioning of feet while climbing stairs)
		Reacts to stimulation or emotion (e.g., changes level of engagement; changes breathing rate)
		Uses gestures/ facial expressions interpretable to familiar others
		Reacts or attends when others come close
		Shows awareness of the sensory aspects of objects, environment, or movement (e.g., shows preference for different textures, temperatures, or body positions)

Rank	5. FITNESS, ENDURANCE AND MOTIVATION	Level summaries
order	#8 – Using sporting or activity equipment (mats, balls, bikes, musical instruments) #16 – Seeking out movement challenges #17 – Persevering in movement tasks #18 – Working within physical limits #19 – Completing tasks involving strenuous movement	
	Completes strenuous movement activities comfortably (e.g., at required speed; while maintaining focus on other aspects of task)	
	Adapts movement strategies to meet challenges (e.g., devises new strategy for carrying objects over greater distances; uses alternative travel mode across different surfaces)	
	With planning, achieves maximum involvement possible within physical limits (e.g., conserves energy by combining steps; sits where possible)	
	Adjusts movement response to meet requirements of equipment or activity (e.g., changes movement to keep time with musical rhythms; moves faster in attempt to reach ball)	
	Creates opportunities to move from classroom activities (e.g., different ways to mobilise around classroom; finds novel movement opportunities within routine tasks)	
	Manages a strenuous activity at slowed pace, or with rest periods	
	Initiates an attempt at new or more difficult aspects of tasks (e.g., exerts self to complete task; attempts task on own)	
	Adheres to rules regarding level of involvement and activity choice (e.g., checks with adult before engaging in new activity)	
	Engages in occasional strenuous movement during activity (e.g., during stretching exercises)	
	Uses equipment in familiar activities (e.g., passes items to a partner in a routine task)	
	Attempts greater physical involvement in classroom tasks (e.g., puts hand up to block or reduce helper involvement)	
	Completes tasks within movement capacity with prompting or support (e.g., takes items from backpack when instructed)	
	Maintains energy output for duration of simple routine tasks (e.g., for packing up; for putting away; to move between activities)	
	Relies on direct instruction to regulate involvement (e.g., takes a break when reminded)	
	Attends to properties or functions of equipment (e.g., responds to touch; turns towards)	
	Participates in movement activities that are easily achieved, or provide immediate positive outcome (e.g., moves towards desired object or person)	
	Shows awareness of activities placed nearby (e.g., lifts head; vocalises)	

M5. Delphi Round 3 – Instructions

a) Reporting back and finalising dimensional aspects and standard setting

Category 1: Balance, postural control, positioning contained rubrics for two 4-step items

- #1 - Maintains balance and upright posture;
- #4 - Positioning self to engage in activity

Categorization of these items received no further comment, so is taken as agreed to.

Order of steps and cut points provided here reflect overall composite agreement and include suggested additional steps (in blue) and a suggested breakout of the step ‘Reacts to lost balance’ into two steps (in red), to more accurately reflect the different levels of skill indicated by the examples (‘startles’ as easier than ‘rights head, extends arms’).

Level statements are a compilation/summary of suggestions made.

Please indicate your level of support for the consensus reached so far...

	Agree strongly	Agree	Disagree	Disagree strongly
Order of difficulty of steps	☐	☐	☐	☐
Other (please specify)				
Placement of cutpoints	☐	☐	☐	☐
Other (please specify)				
Placement of additional steps	☐	☐	☐	☐
Other (please specify)				
Placement of breakout of 'Reacts to lost balance'	☐	☐	☐	☐
Other (please specify)				
Level statements	☐	☐	☐	☐
Other (please specify)				

Category 2: Transportation of self and objects contained the rubrics for four 3-step items

- #6 – Moving from one position/ place to another
- #7 – Using movement skills to avoid obstacles or prevent problems occurring
- #9 – Obtaining objects
- #10 – Transporting objects from place to place

This categorisation posed difficulties for panellists in relation to Item 9, while issues with placement of Item 3 (in Category 4 and item 5 (in Category 3), indicated these items would be better placed in this Category 2. The reasoning provided is as follows –

1. *Item 9 (Obtaining objects)* relates to the obtaining of items for manipulation and use rather than object transport, hence its removal to Category 3. Multidimensional item-response modelling (IRT) also indicated a statistically better fit for the item there;
2. *Item 3 (Coordinating response to sensory input)* was found to lack coherence with the skill set of Category 4 (Self-regulation, self-expression and social interaction), contributing to that category being the most difficult for panellists to order and understand. Item 3 was therefore also placed in Category 2 – multidimensional IRT analysis again supported this move;
3. *Item 5 (Remembering a movement sequence)* was originally placed in Category 3 (Manipulation and use of objects, tools and equipment). However, the examples of mobility as well as object control contained in the item steps, and the general nature of the skill (arm-hand-mobility skills, rather than in-hand-manipulation), made it less appropriate for Category 3; therefore, it was transferred to Category 2. Statistical analysis again indicated a better fit there.

In summary, the new set of items for this category are 3, 5, 6, 7 and 10. Panellists were in >80% agreement as to the order of the original set of items, which is reflected here, with the two new items inserted per their order of difficulty from a Rasch item-response analysis, and Item 9 removed.

Two steps (4 & 5) spoke of ‘cooperating’ with the movement requirement. 40% of panellists noted this implies a range of involvements and levels of interest. **In response**, alternative wording (in red) has been provided for your consideration.

Panellists noted where examples did not clearly relate to the category – for example, step 7 here originally spoke of sitting up straight, walking in a walker, removing/putting on a jumper. **In response**, an alternative for the first two options has been provided for your consideration (in red).

Order of steps and cut points provided here reflects the overall agreement with the original set of items but has had the new items inserted at appropriate points in relation to their difficulty level.

Level statements also are a compilation/summary of suggestions, as well as including aspects reflecting the new larger item set.

Please indicate your level of support for these changes and the consensus reached so far...

	Agree strongly	Agree	Disagree	Disagree strongly
Removal of Item 9 (Obtaining objects) to Category 3 (Manipulation and use of objects, tools and equipment)	☐	☐	☐	☐
Other (please specify)				
Inclusion of Item 3 (Coordinating response to sensory input)	☐	☐	☐	☐
Other (please specify)				
Inclusion of Item 5 (Remembering a movement sequence)	☐	☐	☐	☐
Other (please specify)				
Alternative wording for 'cooperates'	☐	☐	☐	☐
Other (please specify)				
Alternative example for step 7 - 'transfer from chair to floor'	☐	☐	☐	☐
Other (please specify)				
Order of difficulty of steps	☐	☐	☐	☐
Other (please specify)				
Placement of cut points	☐	☐	☐	☐
Other (please specify)				
Level statements	☐	☐	☐	☐
Other (please specify)				

Category 3: Manipulation and use of objects and tools contained the rubrics for four 3-step items and one 4-step item

- #5 – Remembering a movement sequence or strategy
- #8 – Using sporting or activity equipment (mat/ball/bike/musical instrument)
- #11 – Managing personal school equipment (bags, books, lunch, clothing)
- #12 – Manipulating and using classroom-related tools and materials
- #13 – Using writing and drawing implements

As noted in the previous section, item 5 proved difficult to rationalise in this category, and was moved to Category 2, while item 9 was found to fit better statistically here. In summary, the new set of items for this category are 8, 9, 11, 12 and 13, which is proposed as being a more logically cohesive set of manual handling and object control items.

Panellists agreed as to the order of the original set of items. Comments and suggestions included –

- removing the third handwriting example at step 9 (focuses to hold pen/pencil lightly), on the basis that a light pen hold is a significantly more difficult to achieve than the other examples of this set (concentrating to operate a joystick and slowing to use a switch)
- a concern with the handwriting example that the descriptions slipped between tasks and skills. **In response**, an alternative set of steps for this item has been developed and placed in the table for your consideration (in blue). The new steps have drawn on Fitts' and Posner's stages of motor learning (cognitive, associative and autonomous), to describe a handwriting skill progression.

In relation to obtaining objects, it was noted that varying strategies for obtaining objects is a higher-level skill than appropriate for an intermediate level. **In response**, alternative wording (in red) has been provided for your consideration – see Category 3, item 8

Variation in terminology (e.g., 'familiar activity', 'routine movement', and 'simple movement sequence'), was noted as possibly confusing. **In response**, the terms used in the assessment are for teacher use, and reflect their understanding, but the terms and expressions used in the level statements are for reporting to other 'stakeholders', such as therapists, so it is important these reflect therapist understanding. The level statements have been adjusted to provide a clearer sense of what is in view in each case, for your consideration.

The ordering of steps and placement of cut-points for this category varied among panellists by 50%, reflecting mainly the different placements of the steps of item 13. This variation, in addition to the removal of item 5 and addition of item 9 has meant greater difficulty arriving at an outcome broadly reflective of panellists' work. This is also the case with the level statements – while largely a compilation/summary of your suggestions, they include additional ideas to incorporate the new set, and the reworked item 13.

Please indicate your level of support for these changes and the consensus reached so far...

	Agree strongly	Agree	Disagree	Disagree strongly
Final set of items - 8, 9, 11, 12 and 13	☐	☐	☐	☐
Other (please specify)				
Alternative item 13 - does this improve on the original item?	☐	☐	☐	☐
Other (please specify)				
Step order	☐	☐	☐	☐
Other (please specify)				
Cut points	☐	☐	☐	☐
Other (please specify)				
Level statements	☐	☐	☐	☐
Other (please specify)				

Category 4: Self-management, social interaction and communication contained the rubrics for four 3-step items

- #2 – Regulating physical tension/ managing physical behaviour & response
- #3 – Coordinating response to sensory input
- #14 – Sharing space interactively
- #15 – Using movement for self-expression & communication

As noted in the previous section, item 3 proved difficult to rationalise in this category, and was moved to Category 2. In summary, the new set of items for this category are 2, 14 and 15.

Panellists found this category the most difficult to order and describe, though with the removal of item 3, there was agreement with the ordering of steps, and the nature of progression of the skills (as shown in the level statements).

Of those who completed the work of this category, the number of levels identified ranged from four to six. These have been rationalised with the removal of step 3, down to three.

Individual concerns included –

- Whether the cognitive component of movement problem-solving should receive more focus. **In response**, the motor learning literature indicates the integration of cognition and movement in successful goal-directed action, which also underlies the concept of 'embodied cognition'. In keeping with this, the cognitive, problem-solving aspects of movement have been built into the rubrics, particularly at Fitts and Posner's 'cognitive level', where conscious attention and reliance on rules supports the process of skill acquisition;
- Whether self-regulation should be tabled as a separate skill;
- The appropriateness of assessing bodily expressiveness/ non-verbal communication. **In response**, there is value in including items that will prompt teachers to notice skills being demonstrated by students with severe disability, who may otherwise be assumed to have little or no movement capacity. In fact, many students demonstrate significant ingenuity in the range of non-verbal expressions they achieve, and in their capacity to manage stress and fluctuating levels of tension, or to learn these skills.

Please indicate your level of support for these changes and the consensus reached so far...

	Agree strongly	Agree	Disagree	Disagree strongly
Composition of this category - 2, 14 and 15	☐	☐	☐	☐
Other (please specify)				
Incorporation of cognition into the rubrics, rather than as a separate stand-alone item	☐	☐	☐	☐
Other (please specify)				
Inclusion of an item on expressive movement capacity	☐	☐	☐	☐
Other (please specify)				
Step order	☐	☐	☐	☐
Other (please specify)				
Cut points	☐	☐	☐	☐
Other (please specify)				
Level statements	☐	☐	☐	☐
Other (please specify)				

Category 5: Fitness, endurance and motivation contained the rubrics for three 3-step items and two 4-step items -

- #8 – Using sporting or activity equipment (mats, balls, bikes, musical instruments)
- #16 – Seeking out movement challenges
- #17 – Persevering in movement tasks
- #18 – Working within physical limits
- #19 – Completing tasks involving strenuous movement

However, item 8 did not fit as well here as hoped, as the steps relate more to the handling and use of sport and activity equipment, than aspects of fitness/ endurance or motivation.

Therefore, it has been removed from Category 5, leaving here items 16 – 19.

There was overall agreement as to item order, though some difficulty with step 8 in the table – *Adheres to rules regarding level of involvement and activity choice (e.g., checks with adult before engaging)*. **In response**, the skill this step is attempting to describe is the ability to regulate one's physical involvement within safe limits using the help of external feedback/ rules/ reminders. Possible better wording for this step has been provided in red, for your consideration.

The number of levels identified for this category ranged from 5-7. With the removal of Item 8, these have been rationalised to five.

Please indicate your level of support for these changes and the consensus reached so far...

	Agree strongly	Agree	Disagree	Disagree strongly
Removal of item 8	☐	☐	☐	☐
Other (please specify)				
Wording of step 8 - 'Refers to and applies rules...'	☐	☐	☐	☐
Other (please specify)				
Step order	☐	☐	☐	☐
Other (please specify)				
Cut points	☐	☐	☐	☐
Other (please specify)				
Level statements	☐	☐	☐	☐
Other (please specify)				

b) Reporting Format Instructions

Results from this assessment can be reported in three ways, for different audiences and purposes –

4. At the single dimension, or 'gist' level (first example in the document): A single 'rocket report', divided into six bands, with a black line indicating the student's current performance level, and a brief description of the overall skill of that learning stage;
5. At the multi-dimensional level (second example): Five dimensions, each standardised into performance levels, with the red text indicating the student's current capacities, and the green highlighted cells indicating the focus of intervention for the next stage of work. These highlighted cells indicate the skills the student is beginning to acquire;
6. At the single item level (third example): Nineteen items, grouped into the five categories, with the student's score for each item provided.

Please provide your thoughts as to target groups and purposes for each of these reporting formats, and the kind of format you would prefer from teachers who are seeking your help with a student such as this.

Single dimension report (n=1) - Recommended target group(s)

Single dimension report - Recommended purpose/use(s)

Category level report (n=5) - Recommended target group(s)

Category level report - Recommended purpose/use(s)

Items level report (n=19) - Recommended target group(s)

Items level report - Recommended purpose/use(s)

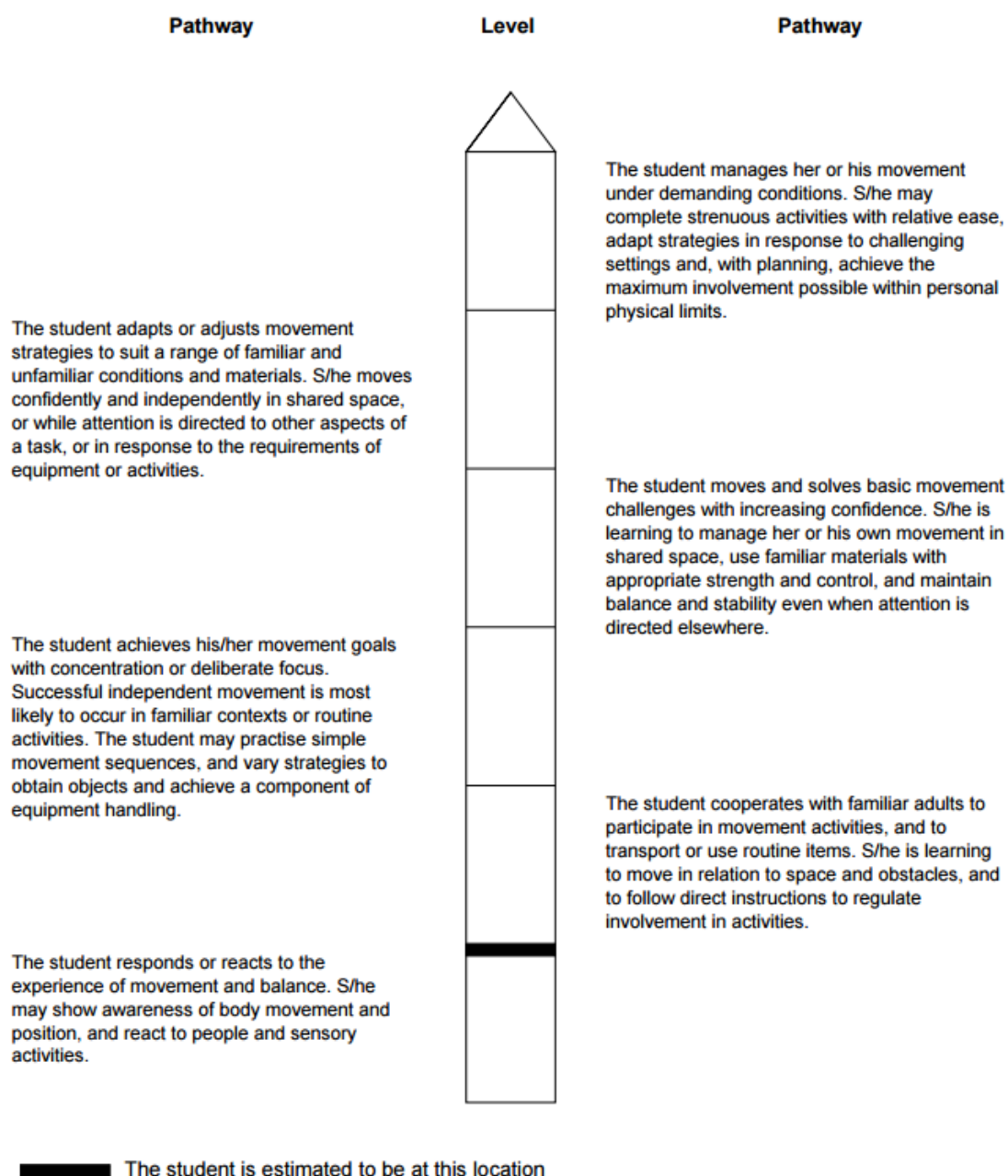
Best reporting format for referral to occupational therapy services

Done

M6: Delphi Round 3 – Reporting Format Options

STUDENT	ZK
AGE	17
GENDER	Male
DIAGNOSIS/ CONDITIONS	Angelman syndrome, intellectual disability, speech difficulties
LIMITATIONS & ASSISTANCE REQUIREMENTS	Limited use of arms and fingers; difficulty gripping objects Requires extensive assistance to participate in learning activities
SCORE	10 (out of 63)

a) Reporting Option 1: Single dimension



b) Reporting Option 2: Multi-dimensions

1. Balance, positioning	2. Transport of self and objects	3. Manipulating objects & tools	4. Communicative/ interactive skills	5. Performance sustainment
	LEVEL 5: The student transports self and/or objects effortlessly and fluently within diverse and dynamically changing environments; he/she achieves multiple additional activity goals concurrently, requiring cognitive attention and dynamic adjustment to unfolding/ unpredictable situations	LEVEL 5: The student achieves automaticity in object manipulation; in written tasks involving linking of motor skills with cognition and language; and bilateral coordination and sequencing in multi-step tasks/activities. He/she transfers and generalises manipulation skills to novel tasks; and achieves fluency and control at speed, and while attending to other aspects of a task		LEVEL 5: The student actively adapts and problem-solves to achieve maximum physical engagement and performance improvement. He/she seeks ways to take advantage of movement opportunities in the environment, and actively devises ways to achieve more physically, while respecting limitations
LEVEL 4: The student smoothly adjusts and readjusts body position to maintain dynamic balance during movement activities, or in response to changing activity requirements. He/she automatically applies a range of strategies to maintain or regain balance and stability in unpredictable or dynamically changing situations	LEVEL 4: The student applies problem-solving skills in response to unexpected task/activity requirements, to continue to safely achieve transport goals. He/she successfully transports objects in more complex, or non-routine tasks. Repetition and practice results in increasingly successful outcomes in terms of efficiency and speed	LEVEL 4: The student refines strategies to calibrate force and rhythm/ timing in relation to handling and using sporting/activity equipment and manipulating and using school tools and materials. He/she engages in repetition and practice to improve writing implement use and control in drawing or letter formation. He/she flexibly adapts hand use to changing activity requirements, and modifies motor responses to achieve best effort	LEVEL 3: The student demonstrates appropriate physical responsiveness to social situations. He/she modulates body posture and body language in response to social cues and modifies physical movement and responses in relation to the needs of others. He/she creatively uses his/her body to communicate subtleties of meaning	LEVEL 4: The student initiates and seeks out movement opportunities and trials variations and novel ways to move. He/she perseveres to complete strenuous tasks, and challenges self to improve. He/she demonstrates more sustained engagement, or attempts to complete longer or more physically demanding routine tasks
LEVEL 3: The student adjusts/ corrects posture and position for optimal task engagement, and responsively corrects lost seated balance if knocked. In mobilising, he/she can maintain balance with attention directed elsewhere	LEVEL 3: The student achieves independent transport of self/objects in routine tasks slowly, with concentration, or in response to modelling/ instruction. He/she engages in practice and/or refining of transport sequences/skills. The focus continues to be on the movement, rather other aspects of the learning activity	LEVEL 3: The student sequences simple movements independently; uses diverse strategies to manipulate objects; demonstrates increased control of motor patterns and sensory discrimination of objects, and applies conscious attention to strategies or instructions to achieve control of writing implements and success in pre-writing	LEVEL 2: The student follows rules and/or strategies to physically navigate shared space and manage own needs and responses. He/she is developing the ability to use his/her body to communicate per standard language conventions	LEVEL 3: The student performs modified fitness tasks to appropriate levels of skill and endurance, demonstrating increasing willingness to physically engage, and interest in completing activities to time requirements, or at the same speed or faster than others
LEVEL 2: The student draws on external cues (physical or verbal) to actively position self and commence activity, and with concentration, can maintain balance and postural control at selected times or during static/ table tasks and activities		LEVEL 2: The student achieves components of tasks requiring hand function with the support of others, or in partner tasks/activities. He/she completes simple routine tasks involving handling and manipulation of objects; demonstrating a range of grasps. He/she can actively hold and explore the use of writing implements		LEVEL 2: The student relies on prompting or support to sustain engagement in routine tasks and regulate involvement re limitations. He/she extends self physically when working with partner or with support of external prompts, and is learning to achieve tasks involving more exertion
LEVEL 1: The student attempts to maintain upright head position in seated position and makes reflexive/sensory responses to lost balance. With support to achieve initial posture, he/she engages in learning activities placed before him/her, relying on direct, ongoing support (e.g., supported seating, positioning aids and modifications)	LEVEL 2: The student responds to, and actively cooperates/ participates with support in routine learning tasks and activities involving transport of self and objects/ items. He/she undertakes components of transport tasks as able, and moves in anticipation of and response to transport components of tasks and activities	LEVEL 1: The student responds to objects placed within reach by using his/her hands to explore their sensory properties, or to obtain/ draw them closer for use	LEVEL 1: The student is developing the ability to respond to others and environmental contexts, with reflexive, and largely sensory movement responses. He/she makes movements for communication, relying on familiar others to interpret their meaning	LEVEL 1: The student moves in response to desired objects or activities close by. He/she demonstrates basic awareness and enjoyment of moving during activity
	LEVEL 1: The student passively experiences and responds to sensory aspects of objects/ movement. He/she relies on adult support and direct assistance to achieve transport goals			

The student is estimated to be performing at these levels

The focus of the next stage of learning

c) Reporting Option 3: Items within categories

CATEGORY 1 – Balance, postural control and positioning**1 Maintaining balance and upright posture (seated or standing)**

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Reacts to lost balance (e.g., startles; rights head; extends arms)
- ☐ 2 Relies on strategies or cues to maintain stable posture (e.g., "feet flat, bottom back to sit up straight")
- ☐ 3 Maintains balance and stability with attention directed elsewhere (e.g., climbs stairs safely in a crowd)
- ☐ 4 Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)

4 Positioning self to engage in activity

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Responds to activity when positioned in front of it (e.g., shows interest; attempts to reach)
- ☐ 2 Assists in being positioned for activity engagement (e.g., leans/ moves in)
- ☐ 3 Positions self to commence activity (e.g., moves into position to enable use of objects/ tools)
- ☐ 4 Anticipates and adjusts position throughout activity to support efficient functioning

CATEGORY 2 – Transport of self and objects**3 Coordinating response to sensory input**

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Attends to the sensory aspects of objects or environment (such as sight, touch, sound, movement through space, or position in relation to gravity)
- ☐ 2 Focuses on the sensation of moving to achieve routine movement tasks (e.g., watches hands to achieve accurate reach; attends to the feel of feet while walking)
- ☐ 3 Practices moving under different sensory conditions (e.g. in time to a rhythm; in reduced light; at different speeds; across different surfaces)
- ☐ 4 Manages performance involving more than one demand (e.g., talks while navigating obstacles; adjusts focus between working on own and with a partner)

5 Remembering a movement sequence or strategy

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Cooperates with the next step of a routine movement (e.g. turns towards; lifts arms)
- ☐ 2 Repeats a simple movement sequence in imitation or from memory (e.g., to sit up straight; walk in walker; remove/put on jumper)
- ☐ 3 Adapts a movement sequence to suit new circumstances (e.g., changes strategy to reach accurately at different speeds; alters gait quickly in response to suddenly changed conditions; combines sequences/ strategies to achieve more of a task)

6 Moving from one position or place to another (with or without mobility aid)

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Shows awareness of being re-positioned or moved (e.g., orients or turns toward direction of travel; reaches to touch surfaces/objects while passing)
- ☐ 2 Focuses, or attends consciously, to reposition self during routine tasks (e.g., attends consciously to placement of feet; focuses to achieve the movement requirements of next step)
- ☐ 3 Masters fluency and control when moving or repositioning quickly (e.g., changes direction smoothly in response to demands of a game; negotiates crowded hallways without difficulty; fluently achieves multi-step tasks)

7 Using movement skills to avoid obstacles or prevent problems occurring

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Reacts when moved around obstacles and through narrow spaces (e.g., holds on; leans in)
- ☐ 2 Attempts to avoid obstacles in familiar settings (e.g., gives wide berth; stops to wait for another to pass)
- ☐ 3 Modifies movement to avoid obstacles that have proved difficult in the past, or that have suddenly arisen (e.g., slows or focuses attention to avoid a trip hazard)

10 Transporting objects from place to place

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Cooperates in tasks involving transport of routine items
- ☐ 2 Concentrates to achieve transport of self and object(s)
- ☐ 3 Transports objects even while engaged on other aspects of activity (e.g., while manipulating objects; while talking; in crowded situations)

CATEGORY 3 – Manipulation and use of objects and tools

8 Using sporting or activity equipment (such as mats, balls, bikes, climbing equipment, musical instruments)

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Attends to properties or functions of equipment (e.g., responds upon touching; turns towards; pushes away)
- ☐ 2 Uses equipment in familiar activities (e.g., passes items to a partner in a routine task)
- ☐ 3 Adjusts movement response to meet requirements of equipment or activity (e.g., changes movement to keep time with different musical rhythms; moves faster in attempt to reach ball)

9 Obtaining objects

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Uses a familiar strategy or method for obtaining objects (e.g., the same raking or swiping strategy for bringing all objects to self)
- ☐ 2 Varies strategies for obtaining objects (e.g., one-handed or two-handed methods)
- ☐ 3 Adapts or adjusts strategies for obtaining objects to suit changing requirements or prevent problems (e.g., alters grip to secure object from falling; retrieves object from table while moving past it)

11 Managing personal school equipment (such as bags, books, lunch, clothing)

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Attends to equipment when placed in hand or nearby (e.g. stills body; holds briefly)
- ☐ 2 Achieves a component of equipment handling (e.g., holds backpack while another closes it)
- ☐ 3 Exploits a range of movement strategies to manage personal school equipment (e.g., uses different body parts to stabilise objects; uses different ways to grip and open lunchbox and food items)

12 Manipulating and using tools and materials (such as pencils, scissors, ruler, keyboard, mouse/switch)

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Responds to sensory properties of tools and materials (e.g. tightens and loosens grip, moves fingers over surface)
- ☐ 2 Focuses or slows to use tools and materials with appropriate strength and control (e.g. concentrates to operate joystick on motorised wheelchair; slows to use mouse or keyboard; focuses to hold pen/ pencil lightly and press gently when writing)
- ☐ 3 Manipulates and uses tools and materials with appropriate strength and control, while attending to other aspects of task (e.g., moves and stabilises paper while writing; releases object accurately while attending to next step of task)

13 Using writing and drawing implements

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Scribbles, or makes marks on the paper
- ☐ 2 Copies or traces over patterns and shapes
- ☐ 3 Achieves legible handwriting when writing slowly and in relation to familiar writing tasks (e.g., when writing own name; when reproducing letters and numbers)
- ☐ 4 Maintains legible and fluent handwriting in demanding or novel writing tasks (e.g., when writing at speed or for long periods; when writing with different sizes/ types of writing implements)

CATEGORY 4 – Communicative/ interactive skills**2 Regulating physical tension**

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Reacts to stimulation or emotion (e.g., changes level of engagement; changes breathing rate)
- ☐ 2 Uses a strategy to manage physical tension during activity (e.g., requests a break; calms by linking breathing to a slow, repetitive movement)
- ☐ 3 Regulates physical tension and response during activities with changing energy demands (e.g., calms for quiet activity following activity with raised energy)

14 Sharing space interactively with others

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Reacts or attends when others come close
- ☐ 2 Manages own needs in shared space (e.g., follows instructions for avoiding bumping into others; experiments with how much room is needed to pass by another safely)
- ☐ 3 Cooperates with others to share the space (e.g., moves responsively; moves over to share desk space)

15 Using movement for self-expression and communication

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Uses gestures interpretable to familiar others
- ☐ 2 Uses a consistent repertoire of gestures/ facial expressions to establish meaning
- ☐ 3 Extends and adapts repertoire of gestures to suit different needs or audiences (e.g., catches a person's eye and then directs their gaze; exaggerates or alters gestures or facial expressions to imitate others or to convey more nuanced meanings)

CATEGORY 5 – Performance sustainment**16 Seeking out movement experiences and challenges**

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Shows awareness of activities placed nearby (e.g., lifts head; vocalises)
- ☐ 2 Attempts greater physical involvement in classroom tasks (e.g., puts hand up to block or reduce helper involvement)
- ☐ 3 Creates opportunities to move from classroom activities (e.g., experiments with different ways to mobilise around classroom; finds novel movement opportunities within routines)

17 Persevering in movement tasks or activities

- ☐ 0 Is moving towards but has not yet achieved this skill
- ☒ 1 Participates in movement activities that are easily achieved, or provide immediate positive outcome (e.g., moves towards desired object or person)
- ☐ 2 Completes tasks within movement capacity with prompting or support (e.g., takes items from backpack when instructed)
- ☐ 3 Initiates an attempt at new or more difficult aspects of tasks (e.g., exerts self to complete task; attempts task on own)
- ☐ 4 Adapts movement strategies in response to more challenging settings (e.g., devises a new strategy for carrying objects over greater distances; uses an alternative way to travel across a different ground surface)

18 Working within physical limits

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Relies on direct instruction to regulate involvement (e.g., takes a break when directed to do so)
- ☐ 2 Adheres to rules regarding level of involvement and activity choice (e.g., checks with adult before engaging in new activity)
- ☐ 3 With planning, achieves maximum involvement possible within physical limits (e.g., conserves energy by combining steps; sits where possible to achieve tasks)

19 Completing tasks involving strenuous movement

- ☒ 0 Is moving towards but has not yet achieved this skill
- ☐ 1 Maintains energy output for duration of simple routine tasks (e.g., packing up; putting away; moving between activities)
- ☐ 2 Engages in occasional strenuous movement during activity (e.g., during stretching exercises; while moving to music)
- ☐ 3 Manages strenuous activity at slowed pace, with rest periods
- ☐ 4 Completes strenuous movement activities comfortably (e.g., at required speed; while maintaining focus on other aspects of task)

M7: Delphi Round 3 – Annotated Multidimensional Report**SUMMARY OF RESPONSES**

1. Order of difficulty of steps – All agreed
2. Placement of cut-points – All agreed
3. Additional steps (#1,2,7,8,9) – All agreed
4. Placement of breakout #3 ‘Reactively responds to lost balance – 4/5 agreed
5. Level statements – All agreed

Category 1- Balance, postural control and positioning

13	Anticipates and adjusts position throughout activity to support efficient functioning in relation to dynamic objects (e.g., during sport/ ball games)	LEVEL 4: The student smoothly adjusts and readjusts body position to maintain dynamic balance during movement activities, or in response to changing activity requirements. He/she automatically applies a range of strategies to maintain or regain balance and stability in unpredictable or dynamically changing situations
12	Masters orientation to gravity during unstable activities (e.g., maintains balance while stretching to reach for objects out of range; leans in to navigate curves when riding a bike)	
11	Maintains balance and stability with attention directed elsewhere (e.g., moves safely through crowded classroom; climbs stairs safely in a crowd)	LEVEL 3: The student adjusts/ corrects posture and position for optimal task engagement and may responsively correct lost seated balance if knocked. In mobilising in familiar situations, he/she maintains balance with attention directed elsewhere
10	Adjusts position throughout familiar activities to support efficient use of static objects (e.g., table-top activities)	
9	Corrects lost seated balance (e.g., maintains position when knocked)	
8	Positions self to commence routine activities (e.g., moves into position for morning routine, to enable use of objects/ tools)	
7	Maintains balance or postural control in selected environments or selected times only (e.g., while completing static task/ table task; when sitting on chair, at start of day)	LEVEL 2: The student draws on external cues (physical or verbal) to actively position self and commence activity, and with concentration, maintains balance and postural control at selected times, or during static/ table tasks and activities
6	Relies on strategies or cues to maintain stable posture (e.g., “feet flat, bottom back to sit up straight”)	
5	Assists in being positioned for activity engagement (e.g., leans/ moves in)	LEVEL 1: The student begins to maintain upright head position in seated positions, and makes reflexive, or sensory responses to loss of balance. With support to
4	Responds to engaging activity when positioned in front of it (e.g., shows interest; attempts to reach)	
3	Reactively responds (involuntary) to lost balance (e.g., startles)	

2	Maintains head in upright position when placed in seated position with trunk support; relies on equipment or adaptations to maintain stable posture and engage in learning activities without tiring	achieve initial postural stability, he/she engages in learning activities placed before him/her, relying on direct and ongoing support to maintain this without tiring (e.g., supported seating, positioning aids, modifications to task/ environment)
1	Reliant on full-support seating to achieve upright head and use of eyes (e.g., head rest, footplates, side support seat belt)	

QUERY – (2 similar comments) 1) #4 is not related to balance/posture... 2) It is challenging to rank skills involving balance in hierarchical order with skills about positioning, though I understand the grouping together makes the report user friendly...

RESPONSE 1 - #4 is a step from the Positioning item. This category consists of two items – 1=Balance; 2=Positioning, each broken out to four graded performance steps, increased to 13 steps following suggested additions in Round 2. So, at the first level of proficiency for this Category, the student achieves these kinds of balance and positioning skills.

QUERY – Level 2 wording clunky – suggest “Given external physical or verbal cues from an adult, the child can maintain balance and postural control at selected times, or during static/ table tasks and activities.”

RESPONSE – Agree a little clunky. We need to retain focus on observable student behaviour, so I have modified the statement to retain that, but to also reflect your suggestion.

QUERY – #11 descriptor about climbing stairs could include easier example also – “moves safely through crowded classroom.”

RESPONSE – That is a good additional example – added. At this level the student’s balance is proficient enough to be backgrounded’, so he/she can tackle more challenging tasks – such as crowds when stair-climbing or moving around the classroom.

QUERY – Level 3’s “In mobilising, he/she is able to maintain balance with attention directed elsewhere”, is too encompassing – use ‘in familiar situations’ as a qualifier perhaps?

RESPONSE – A useful insight – Level 3 concerns ability in familiar settings and Level 4 in unfamiliar... in which case the steps of Level 3 should reflect this – have adjusted #8 & 10 accordingly.

QUERY – Don’t like #3, but as a Level 1 skill, it makes sense. Students have these reflexes due to their disability and in one way this shows some response to balance correction, but as they are involuntary I don’t know how useful this is. Maybe it helps them right their head and not tip over in sitting, and that’s why it’s included?

RESPONSE – It is important to provide a positive, skill-based beginning to teachers, who otherwise see deficits primarily – all the things a severely disabled student d an achievable next step and a way of explaining this to parents: “*I see s/he reacts when his/her balance is lost, so we are now going to work on making that more intentional, to improve safety and independence.*” Teachers then need OT input to facilitate that, but in the first instance they need guidance for their judgements about student capacity and a way of describing that to others, no matter how small, to enable them to fulfil their teaching and reporting responsibilities.

SUMMARY OF RESPONSES

1. Item 9 to Category 3 – All agreed
2. Inclusion of Items 3&5 – All agreed
3. Alternative wording for ‘co-operates’ (Steps 4&5) – All agreed
4. Order of difficulty of steps – All agreed
5. Cut-points and level statements – All agreed

Category 2 – Transportation of self and objects

16	Masters fluency and control when moving or repositioning quickly (e.g., changes direction smoothly in response to demands of a game; negotiates crowded hallways without difficulty)	
15	Manages performance involving more than one demand (e.g., talks while navigating obstacles, or adjusts focus between working on own and with a partner)	LEVEL 5: The student transports self and/or objects effortlessly and fluently within diverse and dynamically changing environments; he/she achieves multiple additional activity goals concurrently, requiring cognitive attention and dynamic adjustment to unfolding/ unpredictable situations
14	Adapts a movement sequence to suit new circumstances (e.g., changes strategy to reach accurately at different speeds; alters gait quickly in response to suddenly changed conditions; combines sequences/ strategies to achieve more of a task)	
13	Transports objects even while engaged on other aspects of activity (e.g., while manipulating objects; while talking; in crowded situations)	
12	Modifies movement to avoid obstacles that have proved difficult in the past, or that have suddenly arisen (e.g., slows to avoid a trip hazard)	LEVEL 4: The student applies problem-solving skills in response to unexpected task/activity requirements, to continue to safely achieve transport goals. He/she successfully transports objects in more complex, or non-routine tasks. Repetition and practice results in increasingly successful outcomes in terms of efficiency and speed
11	Practices moving under different sensory conditions (e.g. in time to a rhythm; in reduced light; at different speeds; across different surfaces)	
10	Concentrates to achieve transport of self and object(s)	
9	Focuses on the sensation of moving to achieve routine movement tasks (e.g., watches hands to reach accurately; attends to the feel of feet while walking)	LEVEL 3: The student achieves independent body and object transport in routine tasks/ activities slowly, with focus and concentration, or in response to modelling/ instruction. He/she engages in practice and/or refining of transport movement sequences/skills. The focus continues to be on the movement, rather other aspects of the learning activity
8	Focuses, or attends consciously, to reposition self during routine tasks (e.g., attends consciously to placement of feet; focuses on the movement requirements of the next step of task)	
7	Repeats simple movement sequence in imitation/ memory (e.g., to transfer from chair to floor; walk in walker)	

6	Attempts to avoid obstacles in familiar settings (e.g., gives wide berth; stops to wait for another to pass)	
5	Cooperates (participates as able) in tasks involving transport of routine items (e.g., holds items on lap while being transported; transports with item loaded by another; is helped to retrieve or rebalance items during transport)	LEVEL 2: The student responds to, and actively cooperates/ participates with support in routine learning tasks and activities involving transport of self and objects/ items. He/she undertakes components of transport tasks as able, and moves in anticipation of and response to transport components of tasks and activities
4	Cooperates with (assists as able in) the next step of a routine movement (e.g. turns towards; lifts arms)	
3	Reacts when moved around obstacles and through narrow spaces (e.g., holds on; leans in)	
2	Attends to the sensory aspects of objects or environment (such as sight, touch, sound, movement through space, or position in relation to gravity)	LEVEL 1: The student passively experiences and responds to sensory aspects of objects, and bodily movement through space. He/she relies on proximity of adult/ support personnel, and direct, ongoing assistance to achieve self or object transport goals
1	Shows awareness of being re-positioned or moved (e.g., orients or turns toward direction of travel; reaches to touch surfaces/objects while passing)	

QUERY – #7 ‘Repeats simple movement from memory’ is a different idea to ‘transfer from chair to floor.’ The memory part is a diversion – isn’t this just a skill that you want to tick off – that they can transfer? Why is memory emphasized?

RESPONSE – Exactly right, this is a ‘transportation of self’ way to check for the skill level of automaticity – if the student has been taught a routine for transferring, are they at the point of automaticity in that?

QUERY – Consider swapping #6 and 7

RESPONSE – These are similar in difficulty (expressed in ‘logits’) - #6 is slightly ‘easier’ (#6=0.716; #7=0.732). As part of the one level, changing them will not make a difference to intervention.

QUERY – Level statements are long – make succinct? (no suggestions)

RESPONSE – Need to be comprehensive enough to support judgements about interventions to progress the student. What is needed beyond this Delphi work, is a gathering of strategies to move students to the next level.

SUMMARY OF RESPONSES

1. Final set of items (8,9,11,12,13) – All agreed
2. Inclusion of Items 3&5 – All agreed
3. Alternative item 13 – improve on the original? – All agreed
4. Order of difficulty of steps – All agreed
5. Cut-points and level statements – All agreed

Category 3 – Manipulation and use of objects and tools

16	Writes fluently and automatically while engaged in another task (e.g., writes while simultaneously processing auditory information and cognitively composing)	LEVEL 5: The student achieves automaticity in object manipulation and use; in written tasks involving linking of motor skills with cognition and language, and successful bilateral coordination and sequencing in multi-step tasks/activities. He/she transfers and generalises manipulation skills to novel tasks; and achieves fluency and control at speed, and while attending to other aspects of a task
15	Manipulates and uses tools and materials with appropriate strength and control, while attending to other aspects of task (e.g., moves and stabilises paper while writing; releases object accurately while attending to next step of task)	
14	Adjusts movement response to meet requirements of equipment or activity (e.g., changes movement to keep time with musical rhythms; moves faster in attempt to reach ball)	LEVEL 4: The student refines strategies to calibrate force and rhythm/ timing in relation to handling and using sporting/activity equipment and manipulating and using school tools and materials. He/she engages in repetition and practice to improve writing implement use and control in drawing or letter formation. He/she flexibly adapts hand use to changing activity requirements, and modifies motor responses to achieve best effort
13	Adapts or adjusts strategies for obtaining objects to suit changing requirements or prevent problems (e.g., alters grip to secure object from falling; holds pen lightly and presses gently when writing)	
12	Alters strategies or positioning to correct writing/drawing errors (e.g., repeats attempts using different positions/ grasps to improve neatness/ position of letters on line)	
11	Accesses a range of movement strategies to manage personal school equipment (e.g., uses different body parts to stabilise objects; uses different ways to grip and open lunchbox and food items)	LEVEL 3: The student sequences simple movements independently; using diverse strategies to manipulate objects. He/she demonstrates increased control of motor patterns and sensory discrimination of objects, and consciously attends to strategies or instructions to achieve control of writing implements and success in pre-writing tasks
10	Relies on externalised strategies in pre-writing tasks (e.g., verbalises or talks through directionality when copying/tracing over shapes)	
9	Focuses or slows to use tools and materials with appropriate strength and control (e.g., concentrates to operate joystick on motorised wheelchair; slows to use switch/keyboard/mouse)	
8	Attempts alternative strategies for obtaining objects (e.g., one-handed or two-handed methods)	LEVEL 2: The student achieves components of tasks requiring hand function with the-support of others, or in

7	Uses equipment in familiar activities (e.g., picks up object to put away; passes items to a partner in a routine task)	partner tasks/activities. He/she completes simple routine tasks involving handling and manipulation of objects; demonstrating a range of grasps. He/she actively holds and explores the use of writing implements
6	Achieves a component of equipment handling (e.g., holds backpack for another to close)	
5	Demonstrates a general idea of the movements required for handwriting (e.g., scribbles, makes marks on paper)	
4	Uses familiar strategy/ method for obtaining objects (e.g., same raking or swiping strategy for bringing objects to self)	LEVEL 1: The student responds to objects placed within reach by using his/her hands to explore their sensory properties, or to obtain/ draw them closer for use
3	Responds to sensory properties of tools and materials (e.g. tightens/loosens grip, moves fingers over)	
2	Attends to properties or functions of equipment (e.g., responds upon touching; turns towards/pushes away)	
1	Attends to equipment when placed in hand or nearby (e.g. stills body; holds briefly)	

QUERY – Level 2 – don't understand 'obtaining in-hand manipulation with support...' This is a solo skill. Verbal prompts and visual demonstrations help, but not physical support.
RESPONSE Agree – now 'requiring hand function'...

QUERY – Level 4 – 'handwriting legibility' difficult – many students with ID may not have achieved meaningful handwriting, while operating at this physical level – perhaps writing implement use or control in letter formation...
RESPONSE Now 'engages in repetition and practice to improve writing implement use and control in drawing or letter formation'

QUERY – #7 additional example – 'picks up objects to put away'
RESPONSE Added. These are examples showing the skill at the level of proficiency in familiar tasks only.

QUERY – #10 wording challenging, though good concept
RESPONSE Now changed to 'Relies on externalised strategies...'

QUERY – #11 – (2 responses) – don't like the verb 'exploits'
RESPONSE 'Accesses' replaces this now.

QUERY – #12 too jargony, though concept an improvement on the original
RESPONSE Now changed to 'Alters strategies or positioning to correct...'

SUMMARY OF RESPONSES

1. Final set of items (2,14,15) – All agreed
2. Incorporating cognition throughout – All agreed
3. Inclusion of item on expressive movement capacity – All agreed
4. Order of difficulty of steps – All agreed
5. Cut-points and level statements – All agreed

Category 4 – Self-management, self-expression/ communication, social interaction

9	Regulates physical tension and response during activities with changing energy demands (e.g., calms for quiet activity following activity with raised energy)	LEVEL 3: The student demonstrates appropriate physical responsiveness to social situations. He/she modulates body posture and body language in response to social cues and modify physical movement and responses in relation to the needs of others. He/she creatively uses the body to communicate subtleties of meaning
8	Extends and adapts repertoire of gestures/ facial expressions to suit different needs or audiences (e.g., catches a person's eye and then directs their gaze; exaggerates or alters gestures or facial expressions to imitate others or to convey more nuanced meanings)	
7	Cooperates with others to share the space (e.g., moves responsively; moves over to share desk space)	
6	Uses a strategy to manage physical tension during activity (e.g., requests a break; calms by linking breathing to a slow, repetitive movement)	LEVEL 2: The student follows rules and/or strategies to physically navigate shared space and manage own needs and responses. He/she is developing the ability to use his/her body to communicate a range of intentions and feelings per standard language conventions
5	Manages own needs in shared space (e.g., follows instructions for avoiding bumping into others; experiments with how much room is needed to pass by another safely)	
4	Uses a consistent repertoire of gestures/ facial expressions to establish meaning	LEVEL 1: The student is developing the ability to respond to others and environmental contexts, with reflexive, and largely sensory responses. He/she makes movements for communication, relying on familiar others to interpret their meaning
3	Reacts to stimulation or emotion (e.g., changes level of engagement; changes breathing rate)	
2	Uses gestures/ facial expressions interpretable to familiar others	
1	Reacts or attends when others come close	

QUERY – Re ‘cognition’ – I can’t see where this has been included – are we perhaps talking about motor planning rather than cognition – the latter is a broad term which relates to many processes – not just associated with movement?

RESPONSE Cognition/ motor planning is inferred in the idea of movement problem-solving and relates to how we improve movement using conscious strategies, e.g., following instructions, experimenting... this relates to Fitts and Posner’s cognitive stage, though research indicates this ‘mental component’ is not contained to just the early stage, but is required throughout, to lift quality to the next level. The reality is, motor planning is not visible until described behaviourally – i.e. until it shows itself in a performance. Checking for motor planning ability therefore concerns our ability to interpret what we see – e.g., the example at #5 – ‘experiments with how much room is needed to pass by another’ is a visible indicator of motor planning – how successfully did the student achieve this?

QUERY – Re expressive movement – it is good to include this, as severely disabled children need others to tune in and read their cues to support their efforts at communication/ social interaction.

RESPONSE Agreed, and these students also need the opportunity to progress their ability to communicate – so this item progresses across its 3 steps to requiring increasing clarity and range in relation to non-verbal intentional communication.

SUMMARY OF RESPONSES

1. Removal of Item 8 – All agreed
2. Wording of step 8 – ‘Refers to and applies rules...’ – 4/5 agreed
3. Inclusion of item on expressive movement capacity – All agreed
4. Order of difficulty of steps – All agreed
5. Cut-points and level statements – All agreed

Category 5 – Fitness, endurance, motivation

14	Completes strenuous movement activities comfortably (e.g., at required speed; while maintaining focus on other aspects of task)	LEVEL 5: The student actively adapts and problem-solves to achieve maximum physical engagement and improvement in performance. He/she seeks ways to take advantage of and exploit the movement opportunities in the environment, and actively devises ways to achieve more physically, while respecting limitations/ physical constraints
13	Adapts movement strategies in response to more challenging settings (e.g., devises a new strategy for carrying objects over greater distances; uses an alternative way to travel across a different ground surface)	
12	With planning, achieves maximum involvement possible within physical limits (e.g., conserves energy by combining steps; sits where possible)	
11	Creates opportunities to move from classroom activities (e.g., different ways to mobilise around classroom; finds novel movement opportunities within routine tasks)	LEVEL 4: The student initiates and seeks out movement opportunities and trials variations and novel ways to move. He/she perseveres to complete strenuous tasks, and challenges self to improve. He/she demonstrates more sustained engagement, or attempts to complete longer or more physically demanding routine tasks
10	Manages a strenuous activity at slowed pace, or with rest periods	
9	Initiates an attempt at new or more difficult aspects of tasks (e.g., exerts self to complete task; attempts task on own)	
8	Refers to and applies rules) to regulate level of involvement and activity choice within safe limits (e.g., checks with adult before engaging in new activity)	LEVEL 3: The student performs modified fitness tasks to appropriate levels of skill and endurance, demonstrating increasing willingness to physically engage, and interest in completing activities to time requirements, or at the same speed or faster than others
7	Engages in occasional strenuous movement during activity (e.g., during stretching exercises; while moving to music)	
6	Attempts greater physical involvement in classroom tasks (e.g., puts hand up to block or reduce helper involvement)	
5	Completes tasks within movement capacity with prompting or support (e.g., takes items from backpack when instructed)	LEVEL 2: The student relies on prompting or support of others to sustain engagement in routine physical tasks, and

4	Maintains energy output for duration of simple routine tasks (e.g., for packing up; for putting away; to move between activities)	to regulate involvement in relation to physical limitations. He/she extends self physically when working with a partner or with the support of external prompts/motivators, and is learning to achieve tasks involving more exertion of effort
3	Relies on direct instruction to regulate involvement (e.g., takes a break when directed to do so)	
2	Participates in movement activities that are easily achieved, or provide immediate positive outcome (e.g., moves towards desired object or person)	LEVEL 1: The student moves in response to desired objects or activities in close proximity. He/she demonstrates basic awareness of movement and enjoyment in moving or being moved during motor activity engagement
1	Shows awareness of activities placed nearby (e.g., lifts head; vocalises)	

QUERY – Step 8 – suggest ‘checks with adult before engaging in new physical activity, to ensure it is completed safely’

RESPONSE Wording choice difficult, as teachers may then focus on behaviour/ compliance in considering this step, rather than self-management in relation to physical limitations – I feel the original wording supports this goal a little better.