Ways in which teachers plan for, implement, and review the use of learning objects as part of a primary school mathematics program

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Declaration of originality

This thesis does not contain material which has been accepted for any other degree in any university. To the best of my knowledge and belief, this thesis contains no material previously published or written by any other person, except where due reference is given in the text.

...................................................   ...................................................
Leanne Rowe     Date
Abstract

A large investment has been made by the state and federal governments in an initiative to develop quality online teaching resources known as learning objects. This initiative is known as The Learning Federation (TLF). These resources have been shown to improve engagement and understanding in mathematics (Clarke & Gronn 2004; Cox, Webb, Abbott, Blakeley, Beauchamp & Rhodes 2004; Freebody 2005). Reports from a number of the state education departments and New Zealand Ministry of Education (Huntington 2006) indicate many teachers do not currently include learning objects in their programs. This four subject multiple case study, which investigated the processes undertaken for teachers to plan, implement and evaluate the use of learning objects, may assist other teachers to do so and contribute to ensuring The Learning Federation initiative makes a difference in the classroom. Results of the case study indicate that teachers approach the use of learning objects in primary mathematics in a fairly standard manner in which the learning objects are used as practice or reinforcement activities by individual students. Teachers also approach classroom management, planning and assessment in fairly consistent ways.
Chapter 1: Introduction

The Learning Federation, a government funded initiative, has been creating online curriculum materials known as learning objects, for teachers and students in Australian and New Zealand schools. The Learning Federation has also been developing the necessary infrastructure to allow these materials to be accessed by the educational jurisdictions who will in turn distribute them to teachers for use in classroom programs.

The researcher considered that it would be useful if guidelines were available to assist teachers to implement learning objects into their classroom programs. To date, such guidelines have yet to be developed.

This study aimed to outline ways teachers, who were part of the case study, planned for, implemented and reviewed the effective use of learning objects as part of a primary school mathematics program. It was intended that this type of information would allow other teachers to consider the practices of the teachers in the case studies and adapt them to their own situations. A significant investment had been made by the Australian and New Zealand educational jurisdictions towards the development of quality online digital content. Early research has shown that teachers and students want to use this content in classroom programs (Freebody 2005, Muirhead & Haughey 2005).
“Several teachers indicated they were looking forward to using the learning objects for the same topic next year. Based on their experiences they plan to use them more efficiently and effectively and in a more focused way” (Clarke & Gronn 2004, p.36).

Cox, Webb, Abbott, Blakeley, Beauchamp & Rhodes (2003) found that teachers’ ability and willingness to use ICT in classroom teaching, in part, depended on teachers’ pedagogical knowledge and practices using ICT: “Teachers need extensive knowledge of ICT to be able to select the most appropriate resources. They also need to understand how to incorporate the use of ICT into their lessons; they may need to develop new pedagogies” (Cox et al. 2003, p.3). The authors went on to say that the research to date does not outline the planning and preparation undertaken by teachers in order to confidently and effectively use ICT in their classroom programs.

The need for research into teacher practices that result in effective use of ICT or learning objects in the classroom has been raised by a number of researchers. The research proposed in this document aims to contribute to this body of knowledge.

Freebody (2006) suggested that “there is now a reasonable well-established body of empirical work on the nature of efficiency of ICT in schools classrooms” (p.8) but proposes that “the task now is to encourage and document the broadest possible range of good practices with learning objects” (p.22).

Muirhead and Haughey (2005) considered research is required in “the most effective ways to enhance the use of learning objects in the classroom” (p.10). Yelland (2000) recommends that “a set of exemplary teaching practices incorporating the use of ICT … should be commissioned” (p.29).
Finally, Slavin (2004) believed that as education researchers we have an obligation to address ‘what works’. This case study intended to address ‘what works’ in terms of the teacher’s role and practice when using learning objects in primary mathematics. “We need many more studies, so that we can give practitioners and policy makers reliable, well-founded information on the decisions they must make” (p.27).

**Rationale and context**

As identified in the literature review Freebody (2006) believes there is substantial research into the efficiency of classroom use of ICT and he recommends that the focus should be encouraging and documenting a broad possible range of good practices where learning objects are integrated into classroom programs. While there is a significant body of literature available on what learning objects are, on the effects of ICT on motivation and attainment, on whole-school implementation strategies and evidence supporting the use of ICT in classrooms, there is little available regarding planning, practice and evaluation to assist teachers in the effective use of ICT in primary classroom mathematics programs in particular.

There is little research available that specifically addresses the planning and preparation teachers undertake in order to use learning objects within their mathematics lessons. Existing research does contribute to an understanding about what learning objects are, the role and impact of technology use in classroom programs, specifically mathematics, and the pedagogy associated with the use of technology. Much of the research addresses the use of ICT rather than learning
objects themselves, although the body of research into learning objects continues to grow.

Learning objects

Although teachers have taught effective classroom programs which do not incorporate learning objects for many years (cited in Fox 2000) ICT, including the use of learning objects, has a positive effect on students’ learning outcomes (Clarke & Gronn 2004; Cox et al. 2004; Freebody 2005). Research has shown that students are motivated to use learning objects and become engaged in the learning activity (Clarke & Gronn 2004; Freebody 2005) and Cox et al. (2004) claims that the use of ICT in mathematics has been shown to have positive effects on pupils’ attainment.

Participants in this study already had knowledge of learning objects and believed they were a useful resource to integrate into their primary mathematics lessons. The study aimed to get a better understanding of teachers’ practices, rather than of student achievement or engagement which have been the research focus in other studies.

Pedagogy

The review of research literature undertaken by Cox et al. (2003) into ICT and pedagogy concluded that “ICT is used effectively and has an impact on learning where teachers are able to appreciate that interactivity requires a new approach to pedagogy” (p.34). Freebody (2006) does not agree with this claim, he considers that teachers are not adopting new pedagogies; rather they are slotting new technologies into their existing classroom practices. Freebody considers that, based on observations of learning object use in a variety of classrooms, teachers are “bringing learning objects to heel” (p.21) and simply using them, as they might any non-digital resource.
Using case study methodology this research study sought to identify how the participating teachers used learning objects; whether the learning objects are simply added on to existing classroom practices or are a catalyst for new pedagogical approaches.

**Teachers’ practice**

There is general agreement that the first steps for the teacher are to identify the learning outcomes and then to carefully select appropriate resources, including digital ones, which meet the needs of the teacher and student and support the learning outcomes (Bratina, Hayes & Blumsack 2002; Clarke & Gronn 2004; Handler n.d.). The teacher’s role, when using ICT in primary mathematics, is important (Fox 2000). Fox believes teachers should be knowledgeable about the software they intend using with their students and that there should be assessment and monitoring of the activity.

Teachers need to know the best way to integrate ICT into the classroom. Teachers require opportunities to “plan, prepare and evaluate learning activities which take advantage of and support the teaching and learning opportunities offered by the online content” (Clarke & Gronn 2004, p.1) to promote higher level thinking in students and ensure that students do not miss the point of the learning object (Cox et al. 2003).

Consideration needed to be given to how the classroom is organised in order to allow maximum learning opportunities, given the learning outcomes and associated task (Cox et al. 2003). Pair, group and whole class use of ICT, possibly through the use of an interactive whiteboard, provides students with opportunities for collaborative work and discussion and teachers with opportunities to gain insights into students thinking (Cox et al. 2003). The teacher’s role is the same as that in non-ICT aided
mathematics, that is, to stimulate discussion in order to develop understanding of the concepts being addressed (Fox and Wilkes 2000).

In this study the concern was to document how teachers selected learning objects and how they used them in teaching and learning. The study also sought to investigate the teacher’s classroom organisation, and their role within the classroom; and whether teachers used learning objects as an aid to assist in the learning of new concepts, as a reinforcement activity, as a culmination task or for some other purpose.
Chapter 2: A review of the literature

The research study investigated and documents ways in which teachers plan for, implement and review the effective use of learning objects as part of a primary school mathematics program, and outlines the implications for teaching and curriculum development.

There is little research available that addresses this specific question; however, recent research does contribute to an understanding about what learning objects are, the importance of technology use in classroom programs (specifically for mathematics teaching) and the pedagogy associated with the use of technology. Much of the research addresses the use of information and communications technology (ICT) in general rather than learning objects specifically; however, the two are closely related. Much of the research regarding the use of ICT in education also applies to the use of learning objects.

“There is now a reasonably well-established body of empirical work on the nature of efficiency of ICT in schools classrooms” (Freebody 2006, p.8); however, Freebody goes on to suggest that “the task now is to encourage and document the broadest possible range of good practices with learning objects”. This literature review supports this view. While there is a significant body of literature available on what learning objects are, the effects of ICT on motivation and attainment and whole-school implementation strategies and literature supporting the use of ICT in classrooms, there is little research available regarding planning, practice and
evaluation to assist teachers in the effective use of ICT in primary classroom mathematics programs.

**Affordances of learning objects**

Teachers have taught effective classroom programs without incorporating digital content for many years, so what is a learning object and why would teachers want to start using them? Teachers might join McKenzie in asking “if your class is not broken, why fix it?” (cited in Fox 2000, p.20).

Learning objects are a form of digital content. The definition of a learning object has been the subject of much debate (Wiley 2000). For the purposes of this research a learning object is a resource which:

- is “one or more digital assets combined and sequenced to create or support a learning experience addressing a curricular outcome(s) for an identified audience(s).” (Alberta Learning, cited in McGreal 2004, p.12); and
- contains metadata which is information about the learning object, which may help a teacher search for resources appropriate to the needs of the learning activity and students. (Smith 2004; Wiley 2000)

In recent times there have been a number of educationalists who argue that the education system being provided currently does not provide maximum opportunities for students of today (Prensky 2001, 2007; Puttnam 2007). Teachers in today’s schools are faced with the difficult task of providing an education to ready students for an unknown future where a regular part of life will involve technologies not yet invented (Puttnam 2007).
“Our students have changed radically. Today’s students are no longer the people our educational system was designed to teach” (Prensky 2001, p.1).

"… the education system remains relatively unchanged and is more attuned to the immediate past rather than the immediate future” (Putnam 2007).

Prensky (2001) talks about the need to teach both ‘legacy’ and ‘future’ content. Legacy content is defined as the traditional curriculum, including mathematics, while future content includes digital and technological content. ICT, including the use of learning objects, which seem to fit into both the ‘legacy’ and ‘future’ content categories, have been shown to have a positive effect on student attainment (Clarke & Gronn 2004; Cox et al. 2004; Freebody 2005, 2006, 2007). Students are motivated to use them and become engaged in the learning activity (Clarke & Gronn 2004; Freebody 2005). Freebody (2006) reports that “students are able to work at their own pace … take responsibility for their own learning” and “find the entry level that suits them” (p.19), which allows for flexibility and choice.

Muspratt and Freebody (2007) found that, while their research indicates that students favour learning objects that are interactive, challenging and have game-like attributes — that is they have multiple pathways, different levels and starting points to allow decision-making and user control — the authors do emphasise that improved learning outcomes are not automatically achieved as a consequence of using learning objects and that the value of a learning object is determined by the quality of the educational environment in which it is used. Muspratt and Freebody consider there is a need to
examine the relationship between teaching and learning activities (including learning objects), pedagogy and learning outcomes.

**ICT in Mathematics**

In their book aimed at assisting pre-service and practising teachers to teach primary school mathematics Zevenbergen, Dole and Wright (2004) discuss the characteristics of students who are sitting in our classrooms today. Most of these students are technologically savvy; they are used to obtaining information from multiple sources, and they need to be prepared for a life beyond compulsory schooling. The authors go on to explain that the mathematics education being offered to today’s students needs to reflect the change in nature of the students and that the diversity within the class should be catered for. “It becomes possible to pose deeper questions about mathematics when using technology …The focus shifts from the process of construction to understanding the reasons, purposes and rationales for undertaking particular work” (p.114).

Including ICT in classroom mathematics programs improves students’ learning (Cox et al. 2004). “The use of ICT in mathematics has been shown to have positive effects on pupils’ learning of different concepts and skills at both primary and secondary levels” (p.5).

Students have a variety of learning styles. Vincent (2003) favours the use of ICT in mathematics to assist those learners with learning styles that are generally not catered to in the classroom. Teachers tend to rely largely on verbal instructions. ICT offers
rich visualisations which provide valuable learning opportunities not only for visual learners but also for students with other learning needs.

Becta ICT Research (2003) carried out a review of research regarding the use of ICT in mathematics education. The research identified that for ICT use to be effective there needed to be a balance with non-computer related learning activities. They found that there were a number of benefits of using ICT in mathematics education, which include:

- feedback being provided to the students immediately and continuously, similar to the way feedback is provided when a teacher works one on one with students,
- opportunities for collaboration between students,
- motivation of both students and teachers that leads to improved performance,
- laborious computations being carried out by the computer, allowing the students to focus on the mathematical strategy, and
- improved learning in the interpretation of graphs.

**Pedagogy**

Schulman’s model of pedagogical reasoning (cited in Cox et al. 2003, p.7) includes the processes of planning, teaching, assessing and evaluating. The research literature review, undertaken by Cox et al. (2003) into ICT and pedagogy, concluded that “ICT is used effectively and has an impact on learning where teachers are able to appreciate that interactivity requires a new approach to pedagogy” (p.34).
Researchers claim that ICT can act as a catalyst for change in the way teachers teach (Bennett & Lockyer 1999; Cox et al. 2003; Cox et al. 2004). “Many teachers are now seeing digital technologies … as environments, rather than just tools, for learning and teaching. The difference between these two perspectives is significant, the former requiring a fundamental change in teaching practice for many teachers” (Way & Beardon 2003).

This claim is challenged by Freebody (2006) who considers that teachers are slotting new technologies into their existing classroom practices. Freebody considers that, in reality, teachers are probably “‘bringing learning objects to heel’, such that their use is made to fit with the imperatives and routines of a standard classroom setting” (Freebody 2006, p.21).

Clements (2002) maintains that the use of ICT supports constructivist principles, where students construct meanings and understandings, when students are presented with authentic tasks that are suited to their needs and intended learning outcomes. Students are guided to question and problem solve. Students are able to investigate using trial and error and are encouraged to report back on their learning. Constructivist learning situations supported with ICT may also lead to a shift in focus from programs that are largely teacher-centred to programs that are more student-centred (Cox et al. 2003), where the role of the teacher becomes one of a facilitator (CEO Forum 2000). Thomas, Tyrell and Bullock (1996) also found that, if a teacher relinquished control and implemented a student-centred program, the result was more discussion, group work and guided discovery.
Teachers must ensure that importance is placed on the processes and learning rather than on the computer (Thomas et al. 1996). It is the role of the teacher to design new learning situations or processes to support learning with ICT (Reynolds, Treharne & Tripp 2003).

**Teachers’ practice**

Fox (2000) stresses the importance of the teacher’s role when using ICT in primary mathematics, saying that it is essential for teachers to be knowledgeable about the software being used and that there should be assessment and monitoring of the activity. “In the worst practice teachers seem happy to hand over responsibility to the machine. This is the ‘go over there and get on with that’ approach to ICT” (p.12).

Students need not only to be given opportunities to use ICT, but also to be encouraged to discuss their work with the teacher or peers. Through these discussions students can explain their approaches and the conceptual thinking behind those approaches and be prompted to try different approaches; teaching can occur when needed (Fox & Wilkes 2000).

Teachers need to know the best way to integrate ICT into the classroom. Teachers require opportunities to “plan, prepare and evaluate learning activities which take advantage of and support the teaching and learning opportunities offered by the online content” (Clarke & Gronn 2004, p.1.) to promote higher level thinking in students (Cox et al. 2003).

Consideration needs to be given to how the classroom is organised, in order to allow maximum learning opportunities, given the learning outcomes and associated tasks.
Pair, group and whole class use of ICT, potentially through the use of an interactive whiteboard, provides students with opportunities for collaborative work and teachers with opportunities to gain insights into students’ thinking (Cox et al. 2003).

Although there are many ways that learning objects can be used in mathematics programs, the “most effective digital practices incorporate digital objects in conjunction with non-digital objects” (Bratina, Hayes & Blumsack 2002). Teachers should carefully consider the intended learning outcomes then select ICT resources which will support the learning outcomes of the curriculum area and integrate the resources into the classroom program where appropriate (Cox et al. 2003).

Although it is common practice for computers to be used by children singularly, in pairs or in small groups, computers, and therefore learning objects, can be used to introduce concepts to a whole class or group using a data projector or interactive whiteboard. The teacher’s role is the same as that in non-ICT-aided mathematics: to stimulate discussion in order to develop understanding of the concepts being addressed (Fox and Wilkes 2000).

**Selection of appropriate material**

“Uses of ICT have a positive effect on pupils’ learning where the use is closely related to learning objectives” (outcomes) (Cox et al. 2004, p.3), therefore careful selection of materials that suit the needs of the teacher and students is crucial (Clarke & Gronn 2004). Cox et al. (2003) go further, stating that for teachers to be able to select resources that are suited to the specific task and students, teachers require an extensive knowledge of ICT.
There is also agreement that the first step, for the teacher, is to identify the learning outcomes then to select appropriate resources, including digital ones, to support the learning activity (Bratina, Hayes & Blumsack 2002; Handler n.d.).

“when selecting … learning objects, the teacher’s first priority is to ensure that the lesson objectives determined by the curriculum form the foundation for the lesson plan; once defined and established, these same lesson objectives should in turn govern the … use of the learning objects” (Bratina, Hayes & Blumsack 2002).

**Implications for the current study**

There are a number of implications arising from the review of the literature. To incorporate ICT, including learning objects, in the most effective manner there needs to be a shift in pedagogy. The emphasis ought to be on student-centred learning rather than teacher-centred programs. The use of ICT is deemed to have positive effects on both engagement and attainment of learning in general, and mathematics specifically. Opportunities for rich discussion arising from the use of ICT should be exploited. To ensure success when using ICT, careful consideration needs to be given to planning, classroom organisation, preparation and selection of appropriate materials, including digital resources.
**Chapter 3: Methodology**

**Design**

Quantitative research has been the predominant method employed for research into the use of ICT in schools (Selwyn 2000). The approach taken to this study however, was grounded in qualitative research in order to discover and document the planning and preparation teachers involved in the case study undertake as they integrate learning objects into mathematics lessons and units. One aim of the study was to ascertain the consequential implications for teaching. “The qualitative researchers’ goal is to better understand human behavior and experience” (Bogdan & Biklen 2003, p.38).

Qualitative research and analysis is more descriptive than quantitative methodologies and aims to gain theoretical understanding. Qualitative research aims to identify themes and theories rather than validate those that already exist, which is the place of quantitative research (Sullivan, 2001).

A grounded theory approach is one which aims to look systematically at qualitative data with the intention of generating a theory. The use of a case study based on grounded theory provides a holistic and systematic approach to developing theories (Strauss & Corbin, 1998). This will increase an understanding of the planning and preparation teachers undertake in order to use learning objects in their mathematics lessons.
**The research focus**

The research questions that guided this study was: 1

**In what ways do teachers plan for, implement, and review the use of learning objects as part of a primary school mathematics program, and what are the implications for teaching and curriculum development?**

The study focused on teachers and teaching practice rather than on students’ learning and explored the following subsidiary questions:

- What planning and preparation took place, including the selection of learning objects, prior to the implementation of primary mathematics lessons and units that use learning objects?
- How were the objects used in the lesson?
- What was the teacher’s role in the lesson, planned versus actual?
- Did teachers use learning objects as an aid to assist in the learning of new concepts, as a reinforcement activity, as a culmination task or for some other purpose?
- How did the teacher assess the students’ learning?
- What evaluation of the teaching program did the teacher undertake in order to reflect on practice and success?

**Assumptions**

For the purposes of this study it was assumed that learning objects are appropriate resources to use in education and that teachers want to use them in their primary
mathematics programs. These assumptions were based on findings reported in recent research outlined in the review of the literature.

**Timing and sequence**

The study took place in four classrooms: two classes from each of two schools (School one and two). Two classes from School one were observed during one term of 2006 and the two classes from School two during term two of 2007. The observations were planned to take place during scheduled mathematics lessons and teachers were interviewed during breaks or after school. Timing was negotiated with the teachers so that there was minimal disruption to regular school life and the opportunity to work around events such as school camps.

**Setting**

The study was conducted in two schools and involved four teachers (each with one class) who expressed an interest in using learning objects in their mathematics programs and volunteered to participate. All data collection was carried out within the schools. The naturalistic setting was selected so that the teachers felt comfortable in their familiar surroundings and the teachers’ regular resources were at hand.

**School one**

School one was a state primary school in the Western metropolitan region of Melbourne. The classes involved were both year one/two composite classes housed in discrete closed plan design classrooms. The students from both classes encompassed a wide range of ability levels, and both teachers were ‘graduate teachers’ (having graduated in the four years prior to the position being undertaken at the time of the research).
School two

School two was a state primary school in the Eastern metropolitan region of Melbourne. The classes involved were a year four class and a year one/two composite class. Both were housed in discrete closed plan design classrooms. The students from both classes encompassed a wide range of ability and both teachers were experienced teachers who had taught in all year levels of the primary school during their teaching careers.

Sampling

The schools involved in the study were selected based on the assumption that within the school at least some teachers had knowledge of learning objects and a general desire to implement them in mathematics programs. This was to avoid the possibility of needing to convince the participants that using learning objects in mathematics teaching and learning was a good thing to do. It was not a requirement that the schools were experienced in the use of learning objects. These schools were identified by the Senior Project Officer of the eLearning Unit in the Innovations Branch of the Victorian Department of Education and Training. The Senior Project Manager is responsible for, amongst other priorities, the implementation and use of learning objects in Victorian state schools and had an awareness of schools’ interest and use of learning objects.

The teachers who volunteered to participate in the study were recruited via communication with the schools’ Principals, ICT coordinators and an information session conducted at staff meetings. All data collection was carried out at the
teacher’s own school so that the teachers felt comfortable in familiar surroundings, resources were at hand and the teachers were not required to travel to participate in the study.

Case study

A case study, as defined by Hartley (1994), is a detailed investigation which may include a group within an organisation with the intention of analysing the processes being studied within the context. The study sought to gain and document a detailed understanding of the steps and processes teachers undertake to plan, implement and review the effective use of learning objects as part of their mathematics program and used a case study approach to do so. Stake (1995) considers that people and/or programs are cases of interest in education. As researchers, we want to understand how people operate in their everyday activities and how and why they make the decisions and choices that they do. Freebody (2003) explains that a case study “focuses on one particular instance of educational experience and attempts to gain theoretical insights from full documentation of that instance” (p.81).

“The decision to focus on qualitative case studies stems from the fact that this design is chosen precisely because researchers are interested in insight, discovery, and interpretation rather than hypothesis testing” (Merriam 1998, pp.28-29). “Case studies are tailor-made for exploring new processes” (Hartley 1994, p.213).

What then defines a case? Merriam (1998) considers that the “single most defining characteristic of case study research lies in delimiting the object of study, the case” (p.27) which is “a single entity, a unit around which there are boundaries” (p.27). That
entity can range from a single case to a group of cases that form a case (Freebody 2003; Merriam 1998; Stake 1995). A case could also be a program or system (Freebody 2003; Stake 1995). In the instance of this study, the ‘case’ was four primary school teachers from two different state schools in the Melbourne Metropolitan region.

**Data collection**

No specific forms of data collection or analysis are prescribed for case studies; the methods that are selected are those which will gather information that will address the research question and “document the story of a naturalistic-experiment-in-action” (Freebody 2003, p.82). Data for this study was gathered to address the central and subsidiary questions of the study through a range of data collection methods which included field, interviews and analysis of documents including planning and teaching documents and photographs.

**Overview**

The researcher used field observations (including participant observation), interviews and analysis of documents to gather data to address the research question. The documents associated with the gathering of data are provided in Appendix A.
Table 3.1: Overview of methods of data collection and data collected

<table>
<thead>
<tr>
<th>Data collection methods</th>
<th>Data collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group orientation meeting.</td>
<td>Field notes and tape recording: experience with ICT integration, learning objects, possibilities for team planning sessions and how many (if any) were considered necessary.</td>
</tr>
<tr>
<td>Planning documents.</td>
<td>Copies of teachers’ unit and lesson planning.</td>
</tr>
<tr>
<td>Lesson observation - one lesson per teacher.</td>
<td>Field notes and tape recording: observations of teachers using learning objects in their program.</td>
</tr>
<tr>
<td>Photographs of observed lesson including classroom layout,</td>
<td>Photographic data that captured the learning setting, classroom management and use of offline resources.</td>
</tr>
<tr>
<td>student instruction on boards if relevant and supporting</td>
<td></td>
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<tr>
<td>teaching resources.</td>
<td></td>
</tr>
<tr>
<td>Semi-structured individual interviews with the individual</td>
<td>Field notes and tape recording: to gather the teachers’ reflections on lessons, what was done and why.</td>
</tr>
<tr>
<td>teachers immediately following the observed lesson.</td>
<td></td>
</tr>
<tr>
<td>Semi-structured individual interviews with the pair of</td>
<td>Field notes and tape recording: 1. to gain the teachers’ reflections on what was done, how and why.</td>
</tr>
<tr>
<td>teachers from each school following the completion of the</td>
<td>2. to gain the teachers’ reflections on what worked, what didn’t, the biggest challenges and what they would do differently next time.</td>
</tr>
<tr>
<td>unit of work or teaching program.</td>
<td></td>
</tr>
</tbody>
</table>
Observation

Observations of teachers conducting mathematics lessons in their classrooms (observations that were planned and relevant to the research topics) increased understanding of the case (Jorgensen 1989; Stake 1995). “Case studies conducted by way of participant observation attempt to describe comprehensively and exhaustively a phenomenon in terms of a research problem” (Jorgensen 1989, p.19).

An observation of a consultation meeting with the researcher, in which the teachers would plan to integrate learning objects into their mathematics lessons, was planned. None of the teachers accepted the invitation to participate in such a session and preferred to plan on their own.

Participant observation

During the classroom observations the researcher took on the role of a participant observer to gain insights from the perspective of the participants being studied (Wiermsa 1995); in other words, as an ‘insider’ (Jorgensen 1989). “Participant observation refers to a process of learning through exposure to or involvement in the day-to-day or routine activities of participants in the research setting” (Schensul, Schensul & LeCompte 1999, p.91).

Participant observation is appropriate for the proposed research as it is useful for studying processes and is especially appropriate when little is known about the phenomenon under study (Jorgensen, 1989). Prior to this study there was little published documentation about how teachers plan, implement and evaluate teaching using learning objects in primary mathematics programs.
It was considered that the study met the criteria required for participant observation according to Jorgensen (1989).

- The activity being investigated was observable within an everyday life situation or setting.
- The researcher was able to gain access to a setting that is relevant to the study.
- The limited size and location allowed the setting of the observation to be studied as a case.
- The research problem could be addressed by qualitative data gathered by direct observation and other methods appropriate to the field setting.

As recommended by Jorgensen (1989), the data gathered from the participant observational study was recorded in an organised manner using field notes, tape recordings, copies of relevant documents and artifacts and photographs.

**Semi-structured individual interviews**

Semi-structured interviews, also known as ‘focused interviews’, were conducted with the teachers after observing their lesson and at the completion of the unit of work. Semi-structured interviews were selected because they “involve an in-depth examination of people and topics” (Minichiello, Aroni, Timewell & Alexander 1995, p.65).

Stake (1995) explains that each interviewee will have different stories to tell and a firm set of survey-like questions does not suit qualitative case study research. “The qualitative interviewer should arrive with a short list of issue-oriented questions,
possibly handing the respondent a copy, indicating there is concern about completing an agenda” (Stake 1995, p.65).

The questions were designed to gather information and the teachers’ perceptions on:

- how successfully the observed lesson and overall unit went
- whether the learning objects were used as expected
- planning and preparation that was undertaken, how this differed from the planning the teacher would normally undertake and what they would do differently with regards to planning in the future
- evaluation of the teaching and learning program
- assessment of the students’ learning.

**Recording the interview**

“Keeping the record of an interview is part of the artistry” (Stake 1995, p.66) Stake (1995) considers that it is not important to record exactly what each respondent said during the interview; it is more worthwhile to listen carefully and take a few pertinent notes. Though transcribing each interview is not necessary, it is critical to capture the meanings and key ideas from the interview. As soon as was possible following the interviews with the teachers, a detailed account of the interview was written up.

During the interviews the researcher:

- took notes of key points during the interview so the main ideas could be recorded while still maintaining focus on controlling the interview, listening to the participants and probing for more depth where required (Stake 1995)
- worked to develop a rapport and establish trust with the participants while attempting to not get too close (Minichiello et al. 1995)
• recorded the interview on a tape recorder for later analysis (Minichiello et al. 1995).

**Document analysis**

While visiting the schools for the lesson observations, documents were collected to add opportunities to further understand each teacher’s planning, preparation, implementation and evaluation. A list of documents intended for collection was created prior to the visits; however, other documents which were seen as useful, but were not included in the list, were also collected. The documents that were collected, but had not been identified for collection in the original list, included posters and instruction sheets informing students how to access the learning objects. “Document summary forms” (which are reproduced in Appendix C) were created and proved useful in the organisation of materials. These forms noted the significance and provided a summary of the document (Miles and Huberman 1994).

The list of artefacts and resources included:

- Unit planner
- Weekly planner
- Student activities to be used in the lesson
- Photographs of student work created during the unit
- Photographs of placement of computers
- Photographs of evidence of organisational structure of lesson: small groups, individual, pairs, whole class.
**Rigour and trustworthiness**

Validation of the study using multiple sources of data was achieved using triangulation and peer review.

**Triangulation**

Triangulation, which Stake refers to as “protocols which do not depend on mere intuition and good intention to ‘get it right’” (1995, p.107), was used to validate data by:

- **Methodological triangulation**, where findings were validated using a variety of data sources: observation of the mathematics lesson followed up with interviews with the teachers and documents and photographs were analysed to cross-reference observation and interview notes.

- **Member checking**, where participants validated that the data was correct.

**Peer review**

It is acknowledged that “Qualitative researchers tend to view reliability as a fit between what they record as data and what actually occurs in the setting under study” (Bogdan & Biklen 2003, p.36). Bogdan & Biklen (2003) consider that “qualitative researchers do not expect that results of observations by different researchers or by the same researcher at different times will be consistent” (p.35), but they are concerned with the accuracy and completeness of their data. In addition, qualitative researchers acknowledge their biases, and, while they attempt to remain objective they acknowledge this is not possible and endeavor to minimise the impact of this bias on research findings (Bogdan & Biklen 2003). In this study several of the writer’s peers,
experienced in educational research, reviewed the findings and provided feedback on the credibility of the findings.

**Data organisation, storage and security**

All materials were collected and stored in an efficient manner. All paper and digital material consisting of the observation write-ups, document summaries, document copies, photographs and interview recordings (some of which take the form of digital files and some microcassettes) has been stored in a secure facility by the Principal Researcher.

**Ethical considerations**

The privacy, anonymity and confidentiality of the teachers and schools involved was considered in all steps of the study (Neuman 1997).

- Consent for contact with the researcher, for the purposes of the research, was sought prior to the research taking place to ensure the participant’s privacy.
- Information gathered was stored in a secure manner in accordance with The University of Melbourne’s Policy on the Management of Research Data and Records.
- Participants’ identity was not disclosed once information gathering began.

It could have been perceived that there was a conflict of interest, given the researcher’s role as both the researcher and an employee of TLF. The scope of the project being undertaken by TLF includes creation of digital resources, online curriculum content and the delivery of this content to the educational jurisdictions but does not include implementation, so there could be no commercial gain for the
company. TLF is a not-for-profit project that is owned and funded by Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA).

**Analysis approach**

No themes or categories were decided prior to the collection of data; the categories were derived from the data using thematic analysis. The data gathered during the interviews, observations and document analysis were analysed to identify themes. This is described as open coding by Strauss and Corbin (1988). The case studies were written up and colour coding was used to identify themes and patterns emerging.

Data displays in the form of grids, also known as matrices, as outlined by Miles and Huberman (1994) and Hurworth (n.d.), were created from the data collected in the interviews and the document analysis: “Matrices essentially involve the crossing of two or more main dimensions or variables … to see how they interact” (Miles and Huberman 1994, p.239). Miles and Huberman consider that using a systematic data display, such as a matrix, greatly contributes to the researcher’s understanding of the information gathered. Semi-fixed grids (Hurworth n.d.) were developed for the document analysis and interviews using charts, codes and colours (LeCompte & Schensul 1999). These grids provided the opportunity to identify the emerging themes and clustering of responses.
Chapter 4: Results

Case studies are presented in this chapter using data collected from the interviews, observations of lessons and the analysis of the documents and artefacts collected during the observation. Six themes emerged from the analysis of the data collected during the study: teacher’s reflections, planning, classroom organisation, assessment, evaluation and assisting teachers. In addition to the creation of the case studies, responses to the interview questions and summary information from documents and artefacts collected during the observations were placed into matrices and analysed to identify themes (matrices reproduced in Appendix C). The themes outline the processes teachers go through in order to use learning objects in primary school mathematics programs and the requirements to enable more efficient use of learning objects for a greater number of teachers.

The case studies are written using the data collected from the four volunteer teachers from:

1. initial orientation interview and the writer’s observation notes, photographs taken in the classroom and documents gathered in the form of planning documents, supporting activities information for students about accessing the learning objects.

2. semi-structured interviews held with the individual teachers immediately following the observation and the pair interview held following the completion of the unit.
Results by case study

Teacher: Natalie

Context

Natalie was a teacher in her second year after graduating who taught a year one/two composite class. Natalie had not used learning objects in her teaching and learning programs prior to this study. She had used other commercial drill and practice type software in her classroom mathematics program. Natalie planned teaching and learning units that focused on one mathematical concept for two weeks and included pre and post testing. If the objectives were not met by the scheduled completion of the program the class would continue learning the concept until the teacher felt most students had reached an acceptable level of understanding. As Natalie had never used learning objects before, she was not familiar with the range of learning objects that were available.

Classroom observation

The lesson took place in the classroom; a comparatively small room with four computers that lined one wall. The seating was organised into four groups of small tables and there was a mat area at the front of the class.

The teacher’s desk was at the back of the class behind the computers, though the teacher did not sit at her desk at any time during the lesson. There was no interactive whiteboard or data projector available in the room. There was a display area at the back of the room for mathematics.
For mathematics the class was divided into four groups, based on ability, which was
determined by general mathematics testing twice a year. The teacher said that next
year she thought she would probably change to “needs-based learning” and group the
students based on their ability in the concept being taught. Three of the groups were
working independently on worksheet tasks (Appendix D) while the lowest ability
group of five students worked with the teacher on the Number trains learning object
on the computers. There were not enough computers for each student to use one on
their own so the teacher instructed three students to work individually and one pair to
share the remaining computer.

Natalie used a weekly mathematics planner (reproduced in Appendix E) to outline the
learning objectives to be addressed that week, the learning focus, intended activities
and teaching discussions. The class had been working on the topic for most of the
week but the teacher found that the learning object she intended using was not
appropriate for her group of students at that time. The class had been focusing on area
of shapes and working out area by counting units. The teacher reviewed a catalogue
listing all TLF’s learning objects, which she had printed from the TLF website, to find
out the areas for which learning objects were available and planned to use them in her
program, including the observed lesson. When the teacher worked through the
learning object closer to the time she wanted to use it with her students, she
discovered it used formulas which she considered too difficult for her class. As a
result the teacher planned a one-off lesson for the day of the observation in which one
group used the Number trains learning object and the remainder of the class worked
on worksheet activities.
The learning objects had been loaded on to the school’s network by the ICT coordinator and organised by concept; for example, Number – exploring. The teacher had written instructions on how to access the learning objects on a chart pinned to the wall above the computers (Appendix F). The students found it easy to follow the instructions to start the learning object.

The class started on the mat with a warm up game of ‘21’, a fun game played by all students in the class. The teacher explained which groups were working on paper activities, using number charts as a reference, and advised them to use unifix blocks if necessary. There were three different groups, each with a different number chart and similar activities (Appendix D).

The learning object, Number trains, requires the students to order carriages that display numbers to form a complete train. The numbers are represented as numerals, words, counting frames and base ten blocks. There are five levels starting with ordering numbers 1 – 10, moving through to the most difficult level, skip counting. The teacher showed the students working on the computers how to get started and sat with students while the voice-over on the learning object read the instructions. She then explained what the students needed to do to complete the learning object. Natalie explained how to work out what number was being represented by the base ten blocks and showed them how to use a number chart to work out what order to put the numbers in. She directed students to easier tasks when they were experiencing difficulty with the level they were working on.
The students working in a pair worked together to solve problems and used a trial and error approach when they were unsure of answers. The computers were placed in one area, which allowed the teacher to work closely to scaffold the students working on the learning objects. The students experienced success in the task and were excited when the train was completed and moved off the track at the completion of a task.

While working on the learning objects, several of the students commented to others in the group that they liked the game.

One of the students became more confident with how the learning object worked and then seemed to improve at working out the order of the numbers. She seemed to show particular improvement in working out which numbers came before the given number. Another student in the group, who was part of the group working on the learning object with the teacher, has learning difficulties and usually works with an integration aide. The aide was absent during the observation so the student worked individually. The teacher indicated that this student needed visual support to assist his learning, that ‘chalk and talk’ did not work well with him and that he responded well to computer activities and games. Natalie had started this student on the easiest level of the series. The student was on task the entire lesson and was successful in the ordering task.

Once the computer group was sure of their task, the teacher circulated around the groups working on the worksheet tasks assisting where required. Towards the end of the lesson the class was called back to the mat for sharing time. Students volunteered to tell the rest of the class about what they had been doing and what they had learnt. Several of the students from the computer group volunteered to share. The teacher asked one of the students from the computer group, “Why do you have that big smile
on your face?” The student explained they played a game on the computer. The teacher asked what it helped them with to which he responded, “I put the numbers in order, I counted in order. At first it was hard as I wasn’t putting them in order.” The teacher said, “I can tell you had fun because you are smiling!” to which the student responded, “I want to do it again”.

At the end of the lesson Natalie commented that she was pleased with the way the students had engaged with the learning object. She said that the students didn’t seem to get bored with the repeated activity of the learning object as they might with paper tasks.

**Interviews**

The teacher reported that the lesson went well but, on reflection, thought that she should have taught an ordering lesson first as it would have been easier for the students to grasp the ordering concept. The teacher noted that one student was using resources around the room to help him complete the tasks on the learning object. Natalie felt the learning object could have been at a harder level for the girls in the group.

Natalie was pleased to see the students were happy using the learning objects. She felt if they were enjoying their work they would try harder and thought that she would use learning objects in her mathematics programs again.

The school has a term planner which outlines which concepts should be covered during each term; the planner does not outline the order the concepts should be taught
in. The teacher had originally planned to work on area during the week of the observation but, once she had a look at the learning object, that addressed the concept of measuring the area of shapes, she considered it was too difficult and chose a learning object addressing number concepts for the lesson instead. Natalie then looked at what learning objects were available for the year level she was teaching, selected on what looked useful from the descriptions in the catalogue and then looked at the learning object herself. Based on her review of the learning object she selected the group of students for whom it would be suitable. She then used her own mathematics activity resource books to find activities that would provide a similar experience for the other groups, even though they were not using the learning objects.

The planning that Natalie undertook for this lesson was the same as the planning she normally undertook when planning for mathematics lessons which involved identifying key concepts from the term planner and locating appropriate resources. For the unit undertaken during the study, her planning involved looking at learning objects, a different type of resource than she would normally use. Natalie thought that if using learning objects in the future she might have the members of the computer group use the learning objects as an individual activity rather than working on them in a teacher focus group. Natalie thought she would probably not use learning objects for assessment purposes.

Upon reflection, the teacher thought that in future she could book the library (where there are a greater number of computers) and take the whole class to work in pairs or small groups. She thought there might be different strategies used by different
students and the class could discuss who had used what strategy during reflection time at the end of the lesson.
**Teacher: Sarina**

**Context**

Sarina was a graduate teacher in a year one/two composite class who used commercially produced mathematics software in her mathematics program. Each week the class worked in small groups on different activities and Sarina aimed to have one of these activities as a computer activity. As the teacher had not used learning objects before being introduced to them as part of this study, she was not completely familiar with what learning objects were available. Sarina had used an area learning object with students in her class after starting the study and prior to the observation.

Sarina taught one focus concept for one or two weeks. She had used the same learning object the day prior to the observation with a less able group.

**Observation**

The lesson took place in the classroom. The classroom seating was arranged in five groups of small tables. There was a mat area at the front of the class near the whiteboard. There were four computers against one wall of the classroom and an internal door joining to another classroom which also had four computers that were available for use on the day of the observation as the neighbouring class was working out of their classroom. The teacher’s desk was at the front of the class though the teacher did not sit at her desk for the duration of the lesson. There was no interactive whiteboard or data projector available in the room.

The focus of the current mathematics unit was number operations. A chart displayed near the mat area showed the students what their group would be doing for that lesson.
The teacher had created posters which showed other names for subtraction, multiplication and division which were displayed around the room.

All learning objects had been loaded on to the school’s network by the ICT coordinator and organised by concept; for example, Number – exploring. The teacher had typed the steps on how to access the learning objects and printed off a copy for each student (Appendix H).

The class was divided into three groups, two working on mathematics games and one on the computers. The game groups worked in pairs while the students on the computers worked individually.

The teacher used a weekly mathematics planner which listed the week’s learning objectives, Victorian Essential Learning Standard levels and learning activities. (Reproduced in Appendix I). Sarina had attended a professional development workshop which focused on using mathematics games to promote understanding in mathematics and, as a result, was planning to use mathematics games in her program wherever possible. The teacher had looked through a catalogue of learning objects, printed from the TLF website, for those that would be applicable to the level her class was working at and would support the concepts she intended teaching. She then had a look at the learning object she had identified earlier to use with the students.

The session started with a whole class game called “higher and lower”. One student wrote down a number, the other students tried to guess the number and were told “higher” or “lower” to help them get to the correct number.
The teacher explained what each of the different groups would be doing for the session. She told the two games groups how to play the games and handed out the game packs. She then told to the computer group how to find the learning objects and also handed out the instructions advising how to do so (Copies of games reproduced in Appendix J).

Sarina circulated amongst the three groups helping where needed. The learning object used in this lesson was ‘The number partner’. In this learning object students use an onscreen model to partition numbers to assist in working out the difference between two numbers. Students who found that learning object too easy were directed to more difficult ones.

Halfway thorough the session, the teacher instructed the games groups to change to the next game planned for their group and explained the new games to each group. The computer group continued to work independently on the learning objects. Many of the students in the computer groups had completed the learning objects they were asked to use and went back to the contents page on the network to find others to play. These were not necessarily related to the current topic and seemed to be one their neighbour had found to be fun or were selected based on how appealing the graphics looked. Some of the learning objects the students had self-selected seemed to be too difficult conceptually for the students.
At the end of the lesson the students packed up the games or computers they were working on. The teacher indicated they would normally have had a sharing or reflection time at the end of the lesson.

**Interviews**

Sarina indicated that she thought the learning object was better suited to the lower ability group who had used it the day before the observation. Although the teacher felt it was probably too easy for the group who used it in the lesson that was observed, she thought that, in general, the lesson went well and reported that when students complete other, paper-based activities they try to “cheat” by copying off each other. She said that in the learning object they couldn’t do this as they had to read through all the instructions and feedback and think about what they were doing.

Sarina worked from topics in the school’s long term planner to plan her mathematics lessons. The long term plan did not include learning objectives, just the topics. She then referred to the Victorian Essential Learning Standards for objectives and found the learning object and some games to match. She considered that the planning was no different to that she would normally undertake in that objectives were identified and resources reviewed for appropriateness. The students worked in small groups and rotated through each of the activities during the week.

The teacher was aiming to assess the students’ learning through sharing time at the end of each lesson. Although there was no focus group and no sharing time in the observed lesson, ordinarily a group of students, usually the focus group who works
with the teacher on the mat, would report back to the rest of the class about what they had learnt.

Sarina thought that there might be other ways to use the learning objects in the future. She thought that, if she had better access to an interactive whiteboard or a data projector, she could use learning objects at the beginning of the lesson to introduce the topic or the lesson.

**Teacher: Helen**

**Context**

Helen taught a year four class with a far greater number of boys than girls. She was an experienced teacher with close to thirty years of teaching experience and had taught in all year levels of the primary school. Helen had been using ICT for around ten years, using it more regularly and integrating into all areas of the curriculum in the few years prior to the study. Helen had a special interest in mathematics and numeracy.

Though Helen had been using learning objects for several years, in the previous two years she had taught at a different year level and was still getting to know what learning objects were suitable for year four. She had found that she had her favourites and that not all the learning objects suited her approach to teaching some concepts. She also used other online mathematics resources including Maths 300, a web-based teaching resource.

**Observation**

The lesson took place in the classroom. Desks were arranged into large groups of eight to ten desks and there were six computers around the walls of the classroom, one
of which was not working, and the teacher’s laptop was also available for use by
classroom. The teacher commented she would like to have organised the classroom differently, but
with the number of students and size of the room, it was not possible. The teacher’s
desk was at the front of the class, though the teacher did not sit at her desk for the
duration of the lesson. There was no interactive whiteboard or data projector available
in the room, though one could be booked for use in the classroom.

The focus of the mathematics teaching and learning was fractions. There were
commercial posters showing fractions using pizza, oranges and toast, and strips of
paper which the teacher had folded to show different fractions with the word written
beside it hung on the whiteboard (Appendix K). There were also posters created by
the students in past lessons. These were fraction walls which differed in content
depending on the student’s readiness (Appendix L). For example, all the fraction
walls included a whole, halves and quarters. Some also included eighths while others
did not and some included thirds while others did not.

The students were grouped into four groups based on their needs for the current topic
and one student was working with an integration aide. The groups were working on a
range of different activities which included:

1. using two learning objects ‘Cassowary fractions’ and ‘Shape fractions’
2. a ‘Faces’ worksheet where students worked out possible outcomes of faces
given specific attributes - this activity was a reinforcement task for the
   previous focus concept (Appendix M)
3. general mathematics games
4. a ‘teacher focus group’ working on the mat with their mathematics exercise book, a glue stick and a pencil on a fractions task which the teacher sourced from The Mathematics Developmental Continuum which was downloaded from the Department of Education & Early Childhood Development website at http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/number/N25001P.htm (Appendix N).

The teacher identified teaching concepts from the school’s long term planner. Though she focused on one particular topic, she said she aimed to incorporate rich tasks so that more than one area could be covered at the one time. She explained that in a measurement unit the emphasis may be on length, area, and perimeter but there was also the opportunity to address decimals, processes, structure, and working mathematically. The tasks were a range of activities, some worksheets from the teacher’s own mathematics teaching books, learning objects, and activities from the Department of Education website mentioned above.

All learning objects were loaded on to the school’s network by the ICT coordinator. Students accessed the school intranet and followed a link to ‘digital resources’. The students were familiar with locating learning objects from the intranet and accessed them efficiently. When planning from home, the teacher would access the learning objects from ‘Digilearn’, the Victorian Department of Education and Early Childhood Development portal for accessing Digital Learning Resources for use in the classroom.
As a warm-up activity the teacher led the students through a series of ‘counting on’ tasks using their calculator. They explored thousands, hundreds, tens and ones and then counted forward in eights and fives. The teacher then guided the students to fold a piece of paper into fifths and then discussed what a fifth was. She then explained what the different groups would be doing during the lesson.

The group that was working with the teacher worked on a worksheet that showed different shapes divided into different fractions (Appendix O). The teacher led a discussion about which fractions were the same and which were different. The students then worked independently to cut the shapes out, pasted them into their books and wrote on other shaded shape that showed the same fraction as the original shape and one that was different.

The computer group worked through the two learning objects independently but, at times, some students assisted others in their group when they were experiencing difficulties (Appendix P). The worksheet group worked on their worksheets independently while the games group worked in pairs or as required by the game they were playing.

**Interviews**

The teacher was happy with the lesson. She reported that the topic had been going for a few weeks and that the students had been engaged and producing good work.

During the observed lesson there were two subgroups within the group that were using the learning objects. The mathematics group who had been working at the highest level for the given topic had used the first learning object before and finished
it quite quickly and then moved on to the second learning object as Helen had hoped. The second subgroup stayed on the one learning object, Cassowary fractions, and worked through it at a slower pace.

The teacher had decided on the focus topic from the school’s long term planner. She found and reviewed resources in her own time; the worksheets and activities were from her own teaching resources and she knew of Cassowary fractions from using it in previous years. Even though Helen was familiar with the learning object, she worked through it before using it with the class in the study to make sure it was appropriate for that group. After reviewing it she decided it was useful for all students, even those in the lowest ability group as they could use ‘guess and check’ strategies to solve the problems. Helen commented that she found it most useful when there were different learning objects with different levels around the same theme: a base one and levels for the students with different abilities. The teacher had planned to use the activity from the teacher focus as part of the assessment, along with observations and anecdotal records.

Helen felt that time was a real issue when selecting learning objects. She considered it took a lot of time to go through the large pool of digital resources to find ones that were appropriate in content and teaching approach and were also at the right level for her class.

The teacher felt that the students enjoyed engaging with the digital content. She thought she would use the data projector in future lessons and use learning objects as the focus of a teacher focus group. She thought that, though some of the less able
students were able to complete the learning objects using a ‘guess and check’ strategy, which although is an appropriate strategy, it was probably not making the best use of the learning object with those students.

Helen felt the planning she had undertaken was the same as she would normally undertake. She considered that reviewing resources to assess what is suitable is a normal part of mathematics planning. Helen only used digital content in her program where the content available was of a high quality and appropriate for the students in her class.

Helen liked using learning objects where there was a series on the same concept but at different levels so that, where appropriate, the students could work through the levels. She also liked the different levels so that the less able students could take part in an activity that looked to be the same as the ones the more able students were using. She was of the opinion it made them feel more included and better about the work they were doing. In future, she thought that if there were no levels within a series of learning objects she would use the learning objects in a teacher focus group.

Helen commented that being part of the study had encouraged her to focus on the evaluation of the way she was using learning objects in mathematics lessons more than she would normally. She thought this had been useful and that it would be beneficial if there was more opportunity in a teacher’s busy schedule to allow more of this reflection.
Digital content was part of the overall fractions unit so the teacher didn’t evaluate the
student’s achievement on the learning objects specifically; rather the learning from
engaging with the learning objects was part of the whole unit. In the fractions unit
Helen annotated notes on a class list as students completed the tasks she had set,
including the learning object. This was her normal approach, though she would also
make use of rich assessment tasks. She had tried getting students to self-evaluate and
often found that when she got students to write down what they had learnt they
reflected on what they did rather than what they learnt.

Helen suggested it would be useful for time poor teachers to have help with searching
for learning objects and linking them to concepts. She had visited the website
developed by the New Zealand Ministry of Education to assist teachers deliver quality
mathematics and numeracy programs, http://www.nzmaths.co.nz. Within the site there
are lists of the learning objects and their relevance to different concepts. Helen
considered that the Mathematics Developmental Continuum, made available by the
Victorian Department of Education and Early Childhood Development, was a useful
resource that linked to a variety of resources including activities from Maths 300,
which included digital interactives. She thought planning and teaching could be made
easier for Victorian teachers if reference was also made to the learning objects from
the Continuum.

**Teacher: Andrea**

**Context**

Andrea was an experienced teacher of 25 years who was teaching in a composite year
one/two class. Andrea had worked in many areas of the primary school, had been
using ICT for the six years prior to the study and had used learning objects for the last
few of those years. Andrea was involved in research conducted by The Learning Federation into the use of digital resources, which are artefacts from cultural institutions that have been digitised such as photos, news segments in the form of video or sound recordings, not learning objects.

Andrea was the ICT coordinator for the school. In addition to the learning objects she also used commercial mathematics software including ‘Targeting maths’ and ‘Maths circus’ in her mathematics programs.

**Observation**

The lesson took place in the classroom; the room was small in size and had five computers along one wall of the classroom, one of which was out of order. There were four large tables for students to work at and there was a mat area at the front of the class near the whiteboard. The teacher’s desk was at the back of the class though the teacher did not sit at her desk for the duration of the lesson. There was no interactive whiteboard or data projector available in the room itself though there is one that can be booked for classroom use.

The focus of the lesson was geometry, specifically identifying shapes and knowing the properties of difference shapes, and number operations, specifically addition and subtraction. Pictures that had been created by the students as part of this unit of work were displayed in the room; the pictures were scenes that had been created using different shapes with the total number of shapes in the picture recorded (Appendix Q).
The class was divided into four groups who were working on different activities which included:

- the ‘number partner’ learning object where students use a bar model to solve addition tasks; the learning object is designed to assist with developing mental strategies for addition by exploring part-whole relationships of numbers; some students worked individually and some in pairs on the computers as there were not enough computers for one each (Appendix R)
- geoboards; a open ended task where the students explored shape and properties of shapes by using rubber bands to create shapes
- a game to practise addition using dice called ‘Addition path’ (Appendix S)
- a teacher focus group working on a worksheet, ‘Identifying shapes’ (Appendix T).

Over time, the mathematics groups changed from topic to topic based on a pre-test or teacher-student discussions, the groups did not change during the stuffy period. The classroom organisation varied depending on the learning requirements for different topics and objectives. At times there was whole class teaching for a week, at other times there may have been one whole class session in the week. During whole class activities groups are drawn out for needs-based teaching.

Focus concepts were taken from the school’s long term planner. The teacher located resources from her own and the school’s teaching resources which she felt contributed to learning the focus concepts.
As the ICT coordinator, Andrea had all learning objects loaded on to the school’s network from DVD. Students accessed the school intranet and followed a link to “digital resources” which included the learning objects for the lesson. The students and teachers could also access the learning objects through ‘Digilearn’, the Victorian Department of Education and Early Childhood Development’s Digital Learning Resources portal.

One student had opened the learning object on the computers for the other students to use. When the students were ready to move on to the next learning object he assisted them in finding and opening it.

The whole class played a warm-up game. The teacher had a pack of flash cards displaying addition and subtraction equations. Students lined up and as each student stood in front of the teacher they were shown a card which they attempted to answer immediately. When students got the answer wrong they were out of the game and sat on the mat. At the conclusion of the game the teacher asked the students how the game could be made quicker and more difficult. The students offered a host of ideas, some interesting and useful.

Following the warm up activity, Andrea drew the students’ attention to the list on the board which showed what each group would be doing for the lesson. She then explained the tasks and where they could find the equipment they needed.

The games group worked in pairs. They practised addition by adding the numbers on the two dice they had rolled to be the first to the end of the game board.
The students who worked on the learning object ‘Number partner’ were a mathematically-able group. They worked through the learning objects quite easily and quickly. Once they had finished they used ‘The slushy sludger’ where they interacted with a ‘yucky’ drink machine and explored probability and the likelihood of getting certain drinks. The students had been working on chance the previous week so this served as reinforcement.

The teacher initially worked with the students completing the worksheet ‘identifying shapes’. Once the students understood the task and were working individually, she moved about the class to assist where needed.

**Interviews**

Andrea was happy with how the lesson went. She felt the students were enjoying themselves as well as learning. Some of the activities used in the lesson were familiar to the students and some were new. Andrea indicated that assessment would take the form of checklists and probably more formal types of assessment.

Some of the students had used the learning object before so they got through it very quickly. She felt that, because the learning object did not have a context, as some do, they did not choose to work through as many of the different tasks as they would have if there was a context.

Andrea commented on how much time it had taken to work out which learning objects were suitable. Though Andrea was still getting to know the affordances of Digilearn, she thought that it might provide some assistance with locating appropriate resources as there was a search option and learning objects were grouped by strand.
Snapshots were also provided which she considered were useful. Digilearn was made available to Victorian state school teachers in the same year the study was undertaken.

The teacher considered that the planning undertaken was no different to the planning she would normally undertake. She thought that in future she would take longer to go through the content, plan to withdraw students needing additional help to a teacher focus group and consider pairing students to work on the learning objects together. She commented that in the past sometimes the selected learning object was successful and sometimes it was not, though the same occurred with the selection of non-digital activities such as worksheets and games.

The evaluation of the program was also the same as she would normally undertake. Andrea evaluated how long the learning objects took the students to complete against the other activities and evaluated whether the students were engaged and seemed to be learning.

Andrea believed that the students enjoyed the interactive activities and learnt well from them. In future she would consider having sharing time at the end of lessons and have the students report on what they achieved. She also thought the printable pages in some of the learning objects may be useful for assessment purposes.

To assist a larger number of teachers to use learning objects in their programs Andrea suggested it would be “wonderful” if the Department of Education could assist teachers in the classroom by providing resources, perhaps in the form of a grant, for a staff member to work through the learning objects and identify which learning object
would be appropriate for the unit of work they were studying at that time. Andrea added that there is so much available—not only learning objects but also web sites and other forms of digital content—but teachers often do not have the time to sort through the wealth of resources to find suitable ones. She believed that there were teachers within the school that had not found the time to look at the learning objects that were available.

Andrea also suggested that more digital content was needed for the junior grades. As a keen user of ICT she would have liked more content, across all key learning areas, for the junior area of the school, as she felt she was sometimes restricted by what was on offer for her students.
Results by theme

Teachers’ reflections on the success of the learning object use

All teachers reported that they were generally happy with the lesson and unit of teaching. They all expressed that they would use learning objects again in their mathematics programs as the students enjoyed interacting with them.

“I was very happy with mine [lesson] … I thought the children were all engaged, they all produced work I was pleased with and they were fully concentrating” (Helen, Interview 2).

“They all seemed to be enjoying what they were doing as they were learning, they were all engaged” (Andrea, Interview 2).

Advantages

The different teachers considered that the learning objects were of assistance to groups of students with different needs. One teacher suggested the learning objects were useful for students who learned best when provided with hands on activities or visual representations. She also thought the students who used the learning objects were more motivated and were not bored as they tended to be in past lessons. She believed the students would put in more effort if they were enjoying their learning activities. One student, who was usually supported by an integration aide who was away on the day of the lesson observation, was on task for the entire lesson, enjoyed his work and happily reported what he had been doing to the class during sharing time.
at the conclusion of the lesson. After the lesson he told the teacher he would like to use the learning object again.

“I would use them again, especially as the kids seem happy doing their activities. If they are enjoying their work they will try harder” (Natalie, Interview 2).

Helen, who had a large number of boys in her class, believed that the boys were very engaged when working with the learning objects. She believed that the students with lower ability in mathematics were relying on ‘guess and check’ strategies while using the learning objects independently and, while this is a valid strategy, she thought the students could get more from the learning object with more teacher support through the use of the learning object with a data projector within a teacher focus group. She added that it was important for those students to feel like they were completing the same task as the mathematically more able students.

One teacher thought that, when using the learning objects, the students read through the information and thought about what they were doing instead of ‘cheating’ from other students as they sometimes did with non-digital activities. Another teacher thought the learning objects catered well to students’ different learning styles.

**Concerns**

The teachers did express some concerns about the observed lesson. These concerns included level of difficulty and timing; two of the teachers thought the learning object they had selected was too easy for either the whole group or some of the students in the group; one teacher commented that the students didn’t engage with the learning object for as long as she thought they would. She thought this was probably because
the learning object did not have a context and so the students did not like working through a number of the tasks that were very similar.

Some of the learning objects have voice support for onscreen text. One of the teachers thought that the learning objects were more useful for students who could adequately read the onscreen instructions and feedback.

**Planning**

There was consensus from the four teachers regarding planning. They agreed that the process they went through with regard to planning was no different to that which they would normally undertake: locating resources and assessing their appropriateness in terms of the needs of the learning outcomes and the needs of the students. They did agree, however, that the time spent on planning when using learning objects was significantly longer than normal.

“It wasn’t different at all. It is how we usually plan” (Andrea, Interview 3).

“Planning was the same as normal, looking for resources like normal and you need to assess if the learning object meets the purpose of the lesson” (Natalie, Interview 3).

“It takes time to go through the learning objects and find the one that is going to link in” (Helen, Interview 2).

All four teachers began their planning process by using the school’s long term planner to identify the concepts that would be addressed. The two teachers from school one
then created weekly mathematics planners and identified the learning outcomes they would be aiming for the student to achieve. Sarina also identified the Victorian Essential Learning Standards levels in her weekly planner. “I pick from one of the high level topics off the long term planner and refer to VELS” (Sarina, Interview 2). The teachers from school two identified the tasks the students would be undertaking in their general weekly planners.

In all instances teachers planned for the students to work independently on the learning objects, or in pairs when there were not enough computers for one each student. One teacher, Natalie, worked through the learning object with the students until she was confident they understood the task.

**Selection of learning objects**

Comment was made by all four teachers in regard to the amount of time it took them to look through the learning objects and review them in terms of appropriateness for the content and teaching approach and suitability for their group of students. Three of the teachers selected learning objects that would be used by all students in the class as a result of mathematics rotations during the week.

Natalie had intended using an area learning object, as area was the concept she was focusing on for that week. When she investigated the learning object in detail closer to the time of the observation lesson, she discovered that the learning object was too difficult for her class as it was using a number of formulas rather than counting units. She then planned a one-off number lesson, found a learning object she thought looked
useful, and selected a specific group to work on the learning object who she felt were most suited to it.

“I looked at the learning object and chose the kids to match” (Natalie, Interview 2).

Andrea commented, that like regular activities, some learning objects were more successful than others but added that students were generally more enthusiastic over the learning objects than other non-digital activities.

“Sometimes you sort through and choose something, sometimes it’s really successful and sometimes it’s not, but you don’t know that until you actually deliver it. That’s the same with a regular activity anyway” (Andrea, Interview 2).

Helen was familiar with some of the learning objects through using them with older students in her class the previous year. She selected some of these learning objects for use in the unit she taught for the period of the study but still chose to work through the intended learning objects again to make sure they were appropriate for her current students.

“I used Cassowary fractions last year so I knew it was there but I did need to go through it in more detail to make sure it was going to cater for the students I have in year four” (Helen, Interview 2).
Non-digital activities

During the observed lesson all teachers began their mathematics lesson with a whole class game or activity. In most cases this was a general mathematics game. Helen was the exception, as her lesson began with a number exploration activity using calculators then a paper folding activity to assist the students’ understanding of what a fifth looks like.

Teachers sourced a variety of non-digital activities which were used by the other small groups while one group was using the learning objects. All teachers, except Natalie who worked with the computer group on a learning object, led teacher focus groups based around a non-digital activity.

While most teachers had selected non-digital activities to support learning of the concepts, learning objectives or levels planned for the week, Natalie, in her one-off number lesson, selected activities she felt would give the students not using the learning object a similar experience in a paper-based format.

Teachers had generally sourced these non-digital activities from their own teaching resources. The activities included worksheets, mathematics games and manipulative equipment such as geo-boards.

“As far as finding the activities I searched out a worksheet and another activity for the teacher focus group” (Helen, Interview 2).
Planning to use learning objects in future

Two of the teachers concluded they would use the same learning objects when revisiting the concepts later in the year and one thought she would also include other learning objects, addressing the same concepts, which she had found since the teaching the unit during the study.

All the teachers reported they would use learning objects again in their mathematics programs and considered they would plan to use the learning objects in a variety of ways when using them in the future. The teacher who used the learning object group as a teacher focus group would use them as an individual activity. The teachers who used them as an individual activity thought they might plan to have students use them in a number of ways: in pairs, on an interactive whiteboard or data projector as a focus group to introduce a concept, or book the laptops for a whole class lesson, and withdraw students who needed extra assistance. One teacher thought that students might use different strategies to solve problems and that sharing time could be used to discuss these different strategies.

“I would draw out the children who need some extra help and create a small focus group that would be based on what we did last time – I could see the ones who need extra help. I might do some pairing up of those who are quite capable with those who need some extra help to navigate around” (Andrea, Interview 3).

Helen, who had been using learning objects for three years, liked series of learning objects that had different levels of difficulty. In future she planned to use learning objects without different levels of difficulty in teacher focus groups for the students in
her class who were less competent on the concept the learning objects were addressing.

**Classroom organisation**

**Grouping**

During the observed lesson all teachers began their mathematics lesson with a whole class game or activity. Following the whole class game all classes were divided into small groups who worked on worksheets, games, tasks or were part of a teacher focus group. In three of the classes the groups were to be rotated on different days of the week giving each group opportunity to complete each activity. In the class doing the one-off number lesson the groups were not going to complete the activities being completed by the other groups; variations of the same activity had been created for each group.

Students were placed into groups based on their ability. In school one the students were grouped according to their performance on a general mathematics test at the start of the year. One of the teachers considered that, in the following year, she would group students differently for each concept according to their needs for that concept, which is how students were grouped in school two.

Teachers reported that, at times, they taught whole class focus groups, mainly to introduce concepts. They said they also did whole class activities and withdrew students who required assistance for that task.
Classroom displays

The displays and resources that were provided to assist student learning varied from class to class though all teachers provided displays and/or resources of some kind. The displays varied from commercially produced posters showing fractions and addition of fractions using food and a hundred chart, to a teacher-produced display of a piece of paper folded into fifths with the words written beside each fifth, and posters of the four number operations showing other words for the operation, for example addition: plus, total, altogether. Students’ work samples, from previous lessons in the unit, were displayed in two of the classes.

Each teacher, with the exception of the teacher conducting the one-off lesson, provided information on the groups’ activities for that day visually as well as verbally. Two of the classes’ activity rotations were displayed on the white/blackboard and one had made a laminated chart for this purpose.

Learning object access

Access to the learning objects was provided to the students through the school’s intranet in all cases. The whole collection of learning objects had been copied onto the school’s server by the ICT coordinator. In the school where students had not used learning objects prior to the study, the teachers provided instructions on a poster or a printed handout. In school two, where learning object use was not new, the year four students knew what learning object they were to use from the rotations list and located the learning object on the intranet themselves. In the year one/two class a student who
was capable on computers had opened the learning object for the other students prior
to the lesson.

**Assessment**

The teachers were planning a variety of approaches in terms of assessing the students’
understanding. The teachers from school one were planning less formalised methods,
including questioning the students as they were working, watching them work to
make sure they were on track and listening to the students’ reports to the class during
sharing time at the conclusion of each lesson. The teachers from school two had
planned to use assessment opportunities that included an activity the students worked
on during the observed lesson, observation and anecdotal records, checklists and
‘formal assessment’ at the conclusion of the unit.

When reflecting about what they might do differently with regards to assessment
when using learning objects in their teaching programs, one of the teachers said she
would not use learning objects for the purposes of assessment whereas two of the
teachers thought they would. Both of these two teachers considered that in some cases
the printable screens provided by the learning objects would be a useful assessment
artifact.

Natalie, who did not use anecdotal notes for assessment during the study thought she
might use anecdotal notes in the future. She thought one-on-one observations would
be useful but deemed they would be difficult to manage. The two beginning teachers
from school one said that, in general, they were still working out the best ways to
assess their students.
Helen, who had not used sharing time to measure students’ progress, thought she might do this in future, asking the students to report back on what they had achieved. Helen said she would not use this approach as she had found in the past that her students had trouble differentiating what they had done from what they had learnt, which is what she was more interested in knowing.

**Evaluation**

Most teachers reported that the evaluation of the teaching program was the same as normal. Andrea had considered what had worked and what had not, the time the learning objects took to complete against the activities the other groups were completing and the time allocated for the mathematics lessons. She had also evaluated whether the students were engaged and learning.

Helen admitted that being involved in the study had given her more cause to reflect on her teaching practice than normal. She considered this was a good thing and thought it would be useful if more opportunities for reflection were encouraged at her school with regard to her everyday programs.

“Going through this does make you reflect on how successful the lesson was, and how you could improve it, and that’s something you don’t get to do on a day to day basis” Helen, Interview 3).
Assisting teachers to use learning objects in mathematics programs

Time seemed to be considered the biggest issue with regard to planning to use learning objects in mathematics programs. The time issue came up a number of times over the course of the study though Helen who had been using learning objects for a number of years, said she was collecting a list of favourites.

“[In future] I would take longer to go through the content” (Natalie, School one).

“Time is a real issue. It takes a lot of time to go through all the pool [of learning objects] and find appropriate ones” (Helen, School two).

“Working out what learning objects are suitable can take a lot of time” (Andrea, School two).

“There are teachers on our staff who haven’t taken the time to even look at the learning objects” (Andrea, School two).

A number of suggestions were made by the teachers familiar with using learning objects addressing how the time issue could be alleviated. Andrea suggested the Department of Education could provide a grant for a staff member to work through the learning objects and identify which learning objects would be appropriate for inclusion in the unit of work they were studying at that time.

Helen also suggested it would be useful to have learning objects linked to mathematics concepts outlined in the Victorian Essentials Standards in a similar way.
as is done for the New Zealand mathematics and statistics curriculum

http://www.nzmaths.co.nz. She considered that the Mathematics Developmental Continuum, provided on the Department of Education and Early Childhood Development website was a useful resource that linked to a variety of resources including activities from Maths 300. She thought it would assist Victorian teachers with planning and teaching if reference was also made to the learning objects.

The development of a larger pool of content was also suggested by both the School two teachers, Andrea adding that she would especially like to see more for the junior grades. As a keen user of ICT, she would have liked more content across all key learning areas for the junior area of the school as she felt she was sometimes restricted by what was on offer for her students.
Chapter 5: Discussion

This case study investigated the ways in which teachers planned for, implemented and reviewed the use of learning objects as part of primary mathematics programs. The planning, preparation, implementation and evaluation were markedly similar for all the teachers. Six themes emerged from the analysis of the interviews with the teachers, observations of lessons and the analysis of documents and artifacts. Five of the themes; teachers’ reflections, planning, classroom organisation, assessment and evaluation are discussed in this chapter (Discussion) while the sixth, assisting teachers, forms the basis of the Implications, recommendations and conclusion chapter.

Teachers’ reflections

All of the teachers who participated in the study regarded the learning objects as useful resources for teaching mathematics, because students were engaged in their learning when using learning objects. Though a number of issues were raised, including the literacy level required to use learning objects (with often no audio support) and the short amount of time required to complete some learning objects as compared with other non-digital activities, the teachers considered they would continue to use them in their programs once the study concluded.

Planning

Pedagogy

As identified in the review of the literature, a number of researchers consider that for ICT to be used effectively in the classroom teachers are required to change their
pedagogy by designing new learning situations or processes to support learning with ICT (Bennett & Lockyer 1999; Cox et al. 2003; Cox et al. 2004; Reynolds, Treharne & Tripp 2003; Way & Beardon 2003). Freebody (2006) does not agree with this claim; rather, he considers that teachers are slotting new technologies, such as learning objects, into their existing classroom practices.

None of the teachers involved in the study appeared to plan a change in pedagogy in order to implement learning objects in their mathematics programs. They were largely included as one of the activities, selected by the teacher, which the students would rotate around during the week. All teachers reflected that, in addition to using learning objects as they had during the research, they would consider using learning objects in different ways in future, be it a whole class demonstration or pairs of students working together on learning objects, though this would not be considered a change of pedagogy. Once teachers become more familiar with the learning objects available and confident using them in their programs, they might be more inclined to approach their teaching practice in new ways.

Fox (2000) considered that there should be assessment and monitoring of ICT activities. The teachers’ monitoring of the students working with the learning objects ranged from working directly with the students using the learning objects, therefore being able to direct and assist closely, to circulating among all the students (including those on the computers) once they had finished with the teacher focus group, to very little monitoring and therefore having little knowledge of the students’ needs and abilities on the activity. The teachers who worked closely with the students using learning objects were able to direct students to learning objects of the appropriate
level if the one they were using was too easy or hard and also to support learning where required.

**Selection of resources, including learning objects**

Bratina, Hayes & Blumsack (2002), Cox et al. (2003) and Handler (n.d.) all agree that the first step, for the teacher, is to identify the learning outcomes, then to select appropriate resources, including digital ones, to support the learning activity. This is the approach that was taken by all of the teachers participating in the study.

All teachers in the study included both digital and non-digital activities in their lessons. Bratina, Hayes & Blumsack (2002) consider this is the best practice and say that the “most effective digital practices incorporate digital objects in conjunction with non-digital objects” (p.5).

Fox (2000) stressed the importance of the teacher’s role when using ICT in primary mathematics, saying that it is essential for teachers to be knowledgeable about the software being used and that there should be assessment and monitoring of the activity. All the teachers reviewed the learning objects they used in their lesson, although the students in one class (who worked independently on the computers) did not appear to have been taught the strategies that were promoted in the learning object which aims to assist with the development of mental strategies for adding and subtracting. This may have been because these strategies were not fully understood by the teacher. As a result the students did not approach the activity as would be anticipated by the designers. The students reverted to algorithmic rather than mental strategies, and seemed to tire of the activity quickly.
The lengthy amount of time required in locating and reviewing learning objects prior to their use in the classroom was raised by all the teachers on more than one occasion during the study. One of the teachers who had been using learning objects for a number of years had collected a list of favourites for future planning. While this is a useful activity, time still needs to be allowed for:

- reviewing newly released learning objects
- locating appropriate learning objects when teachers change the class level they are teaching
- catering for students of differing abilities within the class.

One teacher suggested it would be useful for teachers to have help with searching for learning objects and appropriately linking them to concepts and other activities to support learning. The teacher had used the NZ Maths website which was developed by the New Zealand Ministry of Education to assist teachers deliver quality mathematics and numeracy programs. She considered that the Department of Education and Early Childhood Development’s Mathematics Developmental Continuum, which she thought a very useful resource that already linked to a variety of resources including digital activities from Maths 300, could also be made to link the learning objects. This would reduce the amount of time teachers needed to invest in locating appropriate resources.

Learning object use, in New Zealand schools, increased significantly following the placement of references to learning objects (and links to access them) on the NZ Maths website (Huntington 2006).
The teachers who had used learning objects prior to the study were hoping for more materials to be developed in the future. One teacher made particular reference to the need for more resources for early years’ students.

A teacher from the same school also suggested that it would be useful if a grant could be provided to enable a member of the school’s staff to sort through the learning objects and identify which would be appropriate for inclusion in the unit of work outlined in the school’s long term planners.

**Classroom organisation**

**Grouping**

Though one teacher reported that, in the past, she had used learning objects on a data projector for whole class teaching, most teachers involved in the study planned for the students to work on the learning objects individually. Due to the visual nature of learning objects, and the multiple representations that some learning objects provide, they can be effectively used to introduce concepts to a whole class or group using a data projector or interactive whiteboard. The teacher’s role would be, as it is in lessons that do not include the use of learning objects, to stimulate discussion in order to develop understanding of the concepts (Fox & Wilkes 2000).

An additional role of learning objects during whole class discussions could be to “help the students learn how to use their peers effectively as resources for their learning” (Cobb 1998 p.6). Students should be given opportunities and encouraged to discuss their work with the teacher or peers. The students can explain their approaches and the
conceptual thinking behind their approach, be prompted to try different approaches and teaching can occur when needed (Cox et al. 2003; Fox, Montague-Smith & Wilkes 2000).

**Classroom displays and learning object access**

The classroom displays in the classes participating in the study did not appear to be any different than would be expected in classes not using learning objects. Some learning objects provide print outs which show a record of the student’s activity which could form the basis of a display. It would also be possible to create displays using the print outs to show the strategies the students used when completing the tasks presented in the learning object.

All teachers ensured that the students who were using the learning objects were able to access them quickly through the schools’ intranets. Some teachers provided instructions on a chart or printed sheet. The group of students or the student opening the learning objects for other group members were able to locate the resources with no instructions and were provided the name of the learning object. The more familiar students became with the location of the learning objects the less support they need to locate them.

**Assessment**

None of the teachers involved in the study used learning objects for assessment. While some considered they would not use them for assessment in future, others thought they might. Some teachers considered that the print outs available from some learning objects might be useful for assessment purposes as might observation and
questioning of the students about their learning object use. Information for assessment purposes could also be gathered through group use on an interactive whiteboard.

**Evaluation**

The teachers’ evaluation of their practice involved reflection on what worked and the length of time of the learning object compared to other activities. One teacher commented that being involved in the study had given her more cause to reflect on her teaching practice than normal. She considered this was a good thing and thought it would be useful if more opportunities for reflection were encouraged in her everyday programs.

**Chapter 6: Implications, recommendations and conclusions**

**Implications for teaching**

There are a number of possible implications for teaching arise from the study:

- To become familiar with what learning objects are available, teachers could aim to make a habit of reviewing one or two a week and keep notes on the usefulness and appropriateness of them.
- To provide maximum learning opportunities, teachers could consider the needs of their students and select learning objects that are best suited to the individual students rather than the class as a whole.
- Teachers could consider how they can use learning objects in ways where they can take advantage of teaching opportunities provided by the learning objects and promote rich discussion.
- Teachers could monitor and assess students’ learning, including the use of learning objects.
- If learning objects present strategies that teachers are unaware of, they could familiarise themselves with these and provide learning opportunities for students in using these strategies.
- Teachers could have a back-up plan in the event that learning objects take less time to complete than they had originally planned.

**Implications for curriculum development**

A number of possible implications for curriculum development arise from the study. Organisations involved in curriculum development should consider:

- The provision and promotion of more resources such as those provided by Mathematics Association of Victoria, nzmaths.co.nz and State of NSW, Mathematics K – 6 Programming support of Department of Education and Training (Samples reproduced in Appendix V).
- The development of a larger number of learning objects, especially for students in the early years of primary school - include series of learning objects based on the same concept that have a range of levels in them.
- The showcasing of exemplary practice of using learning objects in mathematics teaching and learning.

**Implications for further research**

It is not statistically viable to make any claims with regards to reliability from a four subject multiple case study. While research of this size is limited in its ability to generate educational theory, it may provide an insight into the processes and
pedagogy associated with integrating learning objects into primary mathematics lessons and units. The limitations of the methods employed include the number of classroom observations and repeated semi-structured interviews. If these were increased in number a greater rapport could have been built with the participants and richer data discovered (Minichiello et al. 1995).

Over the course of this study a number of issues worthy of further investigation have arisen. However, this list is not intended as an exhaustive list of further research associated with learning object use in primary classrooms.

- How does a teacher’s pedagogy change, once they are familiar with learning objects and confident in their use, in the short term and the long term?
- What resources, professional development and support would assist teachers to use learning objects in primary mathematics teaching and learning?
- What are the features of an exemplary teaching and learning program which includes the use of learning objects?
- What blocks and facilitates teacher use of learning objects in primary mathematics programs?

**Recommendations**

Teachers would benefit by knowing the best way to integrate ICT into the classroom. Teachers require opportunities to “plan, prepare and evaluate learning activities which take advantage of and support the teaching and learning opportunities offered by the online content” (Clarke & Gronn 2004, p.1). Models
of exemplary practice using learning objects in primary mathematics teaching could be provided. This could be done through face-to-face professional development courses or through an online community of practice. Planning resources which align learning objects to concepts and other learning resources could be developed. Where these types of support resources already exist they could be actively promoted to schools and teachers. Examples of planning support resources in existence include:

- ‘Resource lists’ and ‘Differentiated unit plans’ provided by The Mathematical Association of Victoria
- ‘Units of work’ provided by the Ministry of Education through NZ Maths

It would be useful if references to learning objects were provided within The Mathematics Developmental Continuum available from the Department of Education & Early Childhood development website.

Schools could assist teachers in the implementation of learning objects by providing opportunities for joint planning and reflection time. They could also seek out grants, such as the Australian School Innovation in Science, Technology and Mathematics (ASISTM) initiative, where funds are provided for projects to bring about improvements to teaching and learning in Science, Technology and Mathematics in Australian schools, to enable interested staff members to become involved in projects to improve and promote learning object use.
**Conclusion**

This case study, which was based on grounded theory, documented the ways that the four teachers who participated in the study, planned for, implemented and reviewed the effective use of learning objects as part of a primary school mathematics program. This documentation could enable other teachers to consider the practices of these teachers and adapt them to their own situations.

For teachers wanting to implement learning objects into their primary school mathematics program the evidence from this research indicates that teachers can do so by simply using them, as a resource for reinforcement or practise, in a way that is consistent with how they use other teaching resources in their regular classroom program. This supports the view of Freebody (2006) who claims that teachers are “‘bringing learning objects to heel’, such that their use is made to fit with the imperatives and routines of a standard classroom setting” (Freebody 2006, p.21).

Six themes emerged from the analysis of the data. The first five provide a structure for teachers, who want to use learning objects in their mathematics program, to consider when planning for and implementing learning objects:

- teacher’s reflections
- planning
- classroom organisation
- assessment
- evaluation.
The final theme, assisting teachers, provides opportunities for those in curriculum development to assist making learning object use easier for teachers when using learning objects as a regular reinforcement activity.

Implications for teaching and curriculum development were discussed using the findings from this study. These implications, along with the recommendations, could also provide advice for teachers wishing to use learning objects in their programs and those involved in curriculum development with regard to professional and resource development. In addition to contributing to the body of research about learning object use this study has also generated a number of areas for further investigation.

Finally, it can be concluded, that while advice can be provided to assist teachers with the implementation of learning objects into primary school mathematics programs, considerable work needs to be carried out, in terms of professional and resource development, in order for new approaches to pedagogy to occur over and above using learning objects as a resource for reinforcement or practise.
References

ASISTM – see Australian School Innovation in Science, Technology and Mathematics.


Bogdan, RC & Biklen, S 2003, *Qualitative research for education*, 4th edn, Allyn & Bacon, Boston, MA.

http://ts.mivu.org/default.asp?show=article&id=961


Hurworth, R n.d., *Analysing qualitative data in evaluation*, University of Melbourne.


82 References


Appendices

Appendix A  Interview questions and observation
**Interview 1: Group orientation meeting**

<table>
<thead>
<tr>
<th>Name</th>
<th>Year level</th>
<th>Tell me about your experience with using IT in mathematics lessons.</th>
<th>What concepts are you covering in mathematics during the time of the data collection of the project?</th>
</tr>
</thead>
</table>
Interview 2: Semi-structured individual interviews following classroom observation

Teacher: Date:

1. How do you feel the lesson went?

2. Did the learning objects get used in the way you expected them to be used?

3. Tell me about the planning that you undertook prior to teaching this lesson

4. Tell me about how you will evaluate the lesson
Interview three: Semi-structured pair interviews at completion of teaching unit

Teachers: Date:

1. How do you feel the unit of teaching went?

2. How has the planning been different to that you would normally undertake?

3. What would you do differently in the future with regards to planning?

4. How has the evaluation been different to that you would normally undertake?

5. What would you do differently in the future with regards to evaluation?
Lesson observation sheet

Teacher:  
Year level:  
Date:  

Lesson focus:

Notes from orientation meeting

Classroom layout

Grouping / class organisation

Planning

Learning object access

Lesson structure

Assessment
Appendix B  Document/artefact summary form template
Document / artifact Summary Form

Site/teacher: 
Date gathered: 

Description and contents

Importance of document

[Insert Scan/ photo ]

[Insert caption]
Appendix C  Data analysis matrices
### Individual interviews – post-lesson

<table>
<thead>
<tr>
<th>Question</th>
<th>Interviewee</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How do you feel the lesson went?</td>
<td>P</td>
<td>The lesson was good but should have done an ordering lesson first as it would have been easier for them to get the concept. One student was using resources around the room to help him. The learning object count have been at a harder level for the girls.</td>
</tr>
<tr>
<td>2. Did the learning objects get used in the way you expected them to be used?</td>
<td>P</td>
<td>Yes, would use them again, especially seeing them happy doing their activities. If they are enjoying their work they will try harder.</td>
</tr>
<tr>
<td>3. Tell me about the planning that you undertook prior to teaching this lesson</td>
<td>P</td>
<td>More working on area this week but at the area LO was too hard so chose a number LO to work with. Looked at the learning object and chose students who it would be suitable for. Thought about what the other kids could do to get the same kind of experience and had a look at resource books. Although not all the students were using the LO they all had a similar experience.</td>
</tr>
<tr>
<td>4. Tell me about how you will assess the students learning</td>
<td>P</td>
<td>By watching the students you need to be with the kids and make sure they are on the right track. Also by questioning the kids as they work.</td>
</tr>
<tr>
<td>5. Any other comments?</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>1. How do you feel the lesson went?</td>
<td>C</td>
<td>The learning object went better with the lower ability group and was too easy for the group.</td>
</tr>
<tr>
<td>2. Did the learning objects get used in the way you expected them to be used?</td>
<td>C</td>
<td>When doing other activities the kids try to cheat. On this they couldn’t. They had to read through it and think about what they were doing.</td>
</tr>
<tr>
<td>3. Tell me about the planning that you undertook prior to teaching this lesson</td>
<td>C</td>
<td>I work from topics from our long term planner. This doesn’t include the objectives, just the topic. I refer to VELS and try to always have a group on the computer. The groups rotate through the activities during the week.</td>
</tr>
<tr>
<td>4. Tell me about how you will assess the students learning</td>
<td>C</td>
<td>I will assess through sharing time at the end of the session. Some students report back, this is normally the focus group who works with me on the mat but I didn’t have a focus group today.</td>
</tr>
<tr>
<td>5. Any other comments?</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>1. How do you feel the lesson went?</td>
<td>B</td>
<td>I was happy with the lesson. The topic has been going for a few weeks. The children were engaged and they produced good work.</td>
</tr>
<tr>
<td>2. Did the learning objects get used in the way you expected them to be used?</td>
<td>B</td>
<td>Yes, there were two different groups within the group that were using the learning objects. The top group, who had used it before, finished it quite quickly and moved on to the second LO which I hoped they would. The second group stayed on at a slower pace.</td>
</tr>
<tr>
<td>3. Tell me about the planning that you undertook prior to teaching this lesson</td>
<td>B</td>
<td>I had decided on the focus from our yearly term planner. I found resources in my own time. I found the worksheets and activities from resources I use and knew of Cassowary fractions from using it in the past but had to work through it and make sure it was ok for this class. It turned out it was ok even for the bottom group who used a guess and check strategy but that’s ok. It is good having the feedback. I find it best when the LOs have different levels: a base one and levels for the students with different abilities to build on. We don’t do unit planning as such.</td>
</tr>
<tr>
<td>4. Tell me about how you will assess the students learning</td>
<td>B</td>
<td>The teacher group activity from the Continuum will form part of the assessment along with observation and anecdotal records. We do a lot of assessment and reporting, ongoing level 2 reporting.</td>
</tr>
<tr>
<td>5. Any other comments?</td>
<td>B</td>
<td>Time is a real issue. It takes a lot of time to go through all the materials and find appropriate resources. There is a curriculum day next term and it has a maths planning focus. It is a two year plan so we will be able to consider what resources are available at this time.</td>
</tr>
</tbody>
</table>

---

**Most old routines with all groups.**

- O go not use.
- Use LO for specific students.

**Most used for reinforcement/practice:**

- Better than learning new concepts (LOs).**
### Pair interviews – post-unit

<table>
<thead>
<tr>
<th>1. How do you feel the unit of teaching went?</th>
<th>2. How has the planning been different to that you would normally undertake?</th>
<th>3. What would you do differently in the future with regards to planning?</th>
<th>4. How has the evaluation been different to that you would normally undertake?</th>
<th>5. What would you do differently in the future with regards to assessment if using LOs in maths teachers?</th>
<th>6. What could be provided to help with implementation or ‘sorting’ of the LOs?</th>
<th>7. Any other comments?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I and C</td>
<td>The planning was the same as normal, but just looking at a different type of resource as well as learning objects.</td>
<td>Perhaps not have the group working on the LOs as the focus teaching group but use the LOs as an individual activity.</td>
<td>It has been the same.</td>
<td>Rate pencilled notes. One on one observations are hard to manage. I probably wouldn’t use LOs for assessment and am still working on the best way to assess the kids in general.</td>
<td>If we had an interactive whiteboard or data projector. I would use learning objects at the beginning of the lesson to introduce the topic or the lesson.</td>
<td>If we had an interactive whiteboard or a data projector. I would use learning objects at the beginning of the lesson to introduce the topic or the lesson.</td>
</tr>
<tr>
<td>M and S</td>
<td>It went well; the learning objects work well if the kids can read – they help them understand. They also demonstrate different styles. They are especially good for kids who need hands on, visual representation. They are more motivated and not scared like they might normally be.</td>
<td>No different at all though probably more pressure knowing someone was going to be watching me.</td>
<td>The students love the interactive activities and learn well from them. I might do rotation ‘feedback time’ at the end of sessions and have the students record on what they achieved.</td>
<td>The students love the interactive activities and learn well from them. I might do rotation ‘feedback time’ at the end of sessions and have the students record on what they achieved.</td>
<td>I think it would be wonderful if the department provide the resource. Perhaps in the form of a grant for a staff member to sort through the LOs and assist the classroom teacher by providing which LO would go with the unit of work they are studying at the time. This has been something I have been thinking for a while, there is so much out there whether it be websites or LOs, but it is the time that it takes to sort through to find the suitable ones. There are still teachers on our staff that haven’t taken the time to even look at the LOs.</td>
<td>More digital content is needed for the junior grades. It helps to gather knowledge as you go.</td>
</tr>
<tr>
<td></td>
<td>You still need to assess if the LOs meet the purpose of the lessons.</td>
<td>Take longer to go through the content and withdrawn kids need different help to a teacher focus group. Also look at pairing students to work on the LOs together.</td>
<td>I have looked at what has worked as I normally would. The timeframe of the LOs didn’t allow the other activities and evaluated whether the kids were engaged and learning.</td>
<td>I have looked at what has worked as I normally would. The timeframe of the LOs didn’t allow the other activities and evaluated whether the kids were engaged and learning.</td>
<td>I think it would be wonderful if the department provide the resource. Perhaps in the form of a grant for a staff member to sort through the LOs and assist the classroom teacher by providing which LO would go with the unit of work they are studying at the time. This has been something I have been thinking for a while, there is so much out there whether it be websites or LOs, but it is the time that it takes to sort through to find the suitable ones. There are still teachers on our staff that haven’t taken the time to even look at the LOs.</td>
<td>More digital content is needed for the junior grades. It helps to gather knowledge as you go.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>More digital content is needed for the junior grades. It helps to gather knowledge as you go.</td>
</tr>
</tbody>
</table>

---

Happy with lesson, will use LOs again, students motivated and engaged.

Manly some feeling for suitability.

Some successful sometimes not.

Conclusion:

- More ideas
- More use of LOs
- More varied activities
- More reflection than normal

---

Classroom experience:

- Use of LOs
- More varied activities
- More reflection than normal

---

Assessment ideas:

- More use of LOs
- More varied activities
- More reflection than normal

---

What would help?

- More digital content
- More varied activities
- More reflection than normal

---

Teacher feedback:

- More digital content
- More varied activities
- More reflection than normal

---

Maths Continuum on the Department of Education and Early Childhood Development websites. There are already links there to Maths 300.
### Document/artifact analysis

| P | Photo shows students working individually at computers. Students from the group working on LOs worked independently on computers except one pair worked together as there were not enough computers for one each. | Photo and copies show activities that the students who were not using the learning objects were completing; for example, writing down odd numbers from 100 - 300 and tools to assist them; 500 chart. (worksheets) | Photo shows a hundred chart assisted students using the learning objects. Weekly maths planner shows key concept, activities and objectives. |
| C | Photo shows students working individually on computers. | Photos show games that were played by students not working on the learning objects. | Photos of displays created by the teacher to show words that mean the same as the four number operations. Weekly maths planner shows focus, activities, objectives and WELS progression points. |
| S | Photo shows students working individually at computers. Students from the group working on LOs worked independently on computers but some provided support to others where help was needed with reading or with working out what to do. | Photos showing students work from previous lessons, related to the current unit of work, which was displayed around the room: fraction walls | Photos of displays including paper folded into fractions with the word for the fraction written beside it and a commercially produced using food to show fraction basics. |
| M | Photo shows students working individually at computers. Students from the group working on LOs worked independently on computers except one pair worked together as there were not enough computers for one each. | Photos showing students work from previous lessons, related to the current unit of work, which was displayed around the room: pictures made with shapes | Copies of activities: Groups networking on the computers played a game “addition path” or did a shapes activities worksheet. |

---

**Classroom organisation**

- **All students worked individually where there were enough computers.**
- **Planning - resources**
- **Displays**
  - Commercially produced
  - Teacher made
Appendix D  Non-digital resources: Natalie

Document / artifact Summary Form

Description and contents

Photos – activities

Students who were not using the LOs were completing tasks which differed depending on what group they were in.

Copy – activities

Copy of activities given to the groups not using learning objects in the observed lesson.

Importance of document

Photos show activities the teacher had selected as part of the teaching and learning. These resources had been sourced from resource books belonging to the teacher. There were the same activities, using different number ranges, depending on the group.

The teacher provided different number charts depending on the task the groups had been given. For example:

The group doing activities which included “Write down all ODD numbers from 1 – 100” were given a 100 chart.

The group doing “Write down all ODD numbers from 100 – 300” were given a 500 chart.
The teacher provided one group with worksheets including a task “Write down all ODD numbers from 100 - 300”. These students were given a 500 chart.

The teacher provided one group with worksheets including a task “Write down all ODD numbers from 1 - 100”. These students were given a 100 chart.
Write down all ODD numbers from 1 - 100

Skip count by 2's starting at 23

Skip count by 5's starting at 11.

I have written a secret number between 40 - 70. It is an even number. What could it be?

Write down the ODD numbers from 500 - 700

Create a pattern where the difference between the numbers is 4 - make sure choose numbers over 500. eg. 514, 518, and 522 etc...

Make a counting back pattern starting at 295. eg 295, 293, 291 etc...

I have a secret number which is more than 324. What could it be and why?

Copy of the different tasks given to the different groups who were not using computers.
Appendix E  Planning document: Natalie
# Maths Planner

**Term: 4  Week: 8**

**Learning Objectives:** To work out multiplication quicker  
To use different strategies to work add and subtract  
To add numbers quicker

<table>
<thead>
<tr>
<th>Whole Class focus</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timetables</td>
<td>Worksheet- 10 sided dice btw 2 extension: 3 digit multiplication</td>
<td>Twinings game (like noughts and crosses 5x5 grid) doubles plus 1 (10 sided dice)</td>
<td>Computers- learning objects- The number partner, using different strategies when adding and subtracting numbers</td>
<td>Revision- o'clock and half past</td>
</tr>
<tr>
<td>Whole Class Activity</td>
<td>skip counting</td>
<td>counting, fill in the grid</td>
<td>higher and lower</td>
<td>Quarter to and quarter past, extension 10 to and 10 past. Using stamps</td>
</tr>
</tbody>
</table>

**A - Established Lv 2 - Extension**

- Cards-in pairs or groups of 3 or 4 multiply two cards together, work out

**B - Competent Lv 2**

- Computers- learning objects- The number partner, using different strategies when adding and subtracting numbers

**C - Beginning Lv 2**

- Computer- learning objects

- Doubles plus 2

- Twinings, number path, double plus one

- Half past O'clock, quarters using mini clocks
Appendix F  Classroom display: Natalie

Document / artifact Summary Form

Site/teacher: School 1, N
Date gathered: 23/11/2006

Description and contents

Photos – classroom display

The teacher had provided a number chart and displayed it on the wall above the computers.

Chart informing students of steps to access the learning objects from the network drive.

Importance of document

The photo shows the teacher has placed a number chart on the wall above the computers where the group was using the learning objects. Some of the students used this number chart to help them order the numbers correctly in the learning object.

Students navigated through the school’s networked folders to open the learning objects.
The teacher had provided a number chart to support the students using the learning objects.

Chart the teacher had created to inform students how to access the learning objects from the school’s network.
Appendix G  Classroom organisation: Natalie

Document / artifact Summary Form

Site/teacher: School 1, N
Date gathered: 23/11/2006

Description and contents

Photos – students working individually ands in pairs on learning objects and individually on worksheets.

Two students worked independently on learning objects and where there were not enough computers two students worked as a pair.

Students in groups working on worksheets worked individually.

Importance of document

Photos show students working on computers individually and two students working as a pair as there were not enough computers for one each. The teacher grouped the two students together as they work at a similar level.

Though the LOs tend to look the same visually the teacher had allocated different learning objects to different students. Most of the students are working on ordering numbers 30 – 50 but one students, who is less able in mathematics, is working on an LO ordering numbers 1 – 20.

Students who were working in groups, allocated to different worksheets, also worked individually.
Student working on ordering numbers LO (nos 1 - 20) individually

Students working on an ordering numbers LO (nos 30 - 50) in a pair.

Students working on a worksheet individually

Students working on computers along the wall of the classroom
Appendix H  Group rotations organisation: Sarina

Document / artifact Summary Form

Site/teacher: School 1, S
Date gathered: 23/11/2006

Description and contents

Photos – classroom organisation

Photos show a chart showing group activity information,

Copy of instructions sheet

steps to inform students how to access the learning objects and learning object navigation on the school’s network.

Importance of document

The teacher had planned the activities for the different groups and that was displayed on a chart near the mat area where the whole class had met at the start of the lesson for their warm-up activity.

The learning objects had been copied on to the intranet from a DVD by the ICT coordinator.

Students navigated through the school’s networked folders to open the learning objects and find others when they had completed the one they were working on.
Group activity chart created by teacher to inform students of their activity for the lesson.

Learning objects navigation on the school network that students used to access the learning objects.
Go into My Computer
Click on Software :M
Click on Learning Objects and Digital Resources
Click on Maths and Numeracy
Click on number_add_subtract_multiply_
Click on Number Partner

Instructions the teacher had created to guide the students to open the learning object were printed and distributed to the groups working on the learning objects.
Appendix I  Planning document: Sarina
<table>
<thead>
<tr>
<th>Day</th>
<th>Focus</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Focus</strong></td>
<td><strong>Area - is the space an object takes up.</strong></td>
<td><strong>Number Bingo</strong></td>
<td><strong>Counting</strong></td>
<td><strong>Celebrity Number</strong></td>
<td><strong>Fill in missing numbers</strong></td>
</tr>
<tr>
<td><strong>Whole Class Activity</strong></td>
<td>Discuss definition of area with students. Ask for examples and model. Students are to find 3 things that there hand can &amp; can't cover fully. They are to record and discuss their findings. Christina to rove</td>
<td>I have covered an object with 20 unifix, what might the object be? Students are to work in pairs to try and find the object with an area of 20 unifix.</td>
<td>1. Write down odd numbers/ even numbers between 100-300 2. Secret Number between 150-180. It is even - what could it be? 3. Create a number pattern where the difference is 10. 4. Skip count by 5’s starting at 74.</td>
<td>Students are to trace shapes onto graph paper. They are to check the area by counting boxes in Graph. When complete, students are to make their own shapes and swap with a partner.</td>
<td></td>
</tr>
<tr>
<td><strong>Teaching Group</strong></td>
<td>Clarify meaning and assist students in finding objects.</td>
<td>Rove between groups.</td>
<td>Learning Objects - Number Trains. Students are to complete their number trains using Learning Object. Leanne to observe.</td>
<td>Give students shapes already drawn - discuss meaning of Area. Students are to find the area of each shape.</td>
<td></td>
</tr>
</tbody>
</table>

**OBJECTIVES:** Students gain an understanding of the meaning of Area. *Students use informal units to measure area of objects. *Students estimate, measure, check and compare Area of an object.
Appendix J  Non-digital mathematics games: Sarina

Document / artifact Summary Form

Site/teacher:  School 1, S
Date gathered:  23/11/2006

Description and contents

Photos – games

Students who were not using the LOs were playing during the lesson:

Importance of document

Photos show activities the teacher had selected as part of the teaching and learning. These resources had been sourced from a professional development session the teacher had attended regarding the use of maths games.

The games seem have learning outcomes addressing similar concepts to those in the learning object the teacher had selected as part of the unit.
Doubling game used by group not using learning objects in this lesson

Addition game used by group not using learning objects in this lesson
Appendix K

Classroom display: Helen

Document / artifact Summary Form

Site/teacher: School 2, H
Date gathered: 18/06/2007

Description and contents

Photos – classroom display

Teacher made fraction wall and commercially produced poster which students can refer to.

Importance of document

Displays were available to support the students in gaining an understanding of the size of different fractions and how many of a particular fraction makes up a whole.

A display on whiteboard, using a length model to represent the relative size of fraction, has the word for the fraction written beside it. This may have been used to assist the students creating their own fraction walls which were displayed around the room.

A commercially produced poster displayed information, using food, about fractions being part of a whole and showing basic addition of fractions to make a whole.
Display on whiteboard showing the relative size of fractions

A commercially produced poster about fractions being part of a whole
Appendix L  Students’ work samples: Helen

Document / artifact Summary Form

Description and contents

Photos – student work samples

Student work from previous lessons, also about fractions relation to other fractions and a whole, was displayed around the room. The charts were good reference pictures for completing other fraction tasks as well as presentation of completed previously activities.

Importance of document

Student’s fraction walls from previous, related lessons were displayed around the classroom. The teacher had planned for the students to create different fraction walls depending on their needs and level of readiness.
Student’s fraction walls from previous, related lessons were displayed around the classroom. This fraction wall includes whole, halves and quarters.

This fraction wall includes wholes, halves, thirds, sixths, ninths, fifths and tenths.
Appendix M  Worksheet activity-faces: Helen

Document / artifact Summary Form

Site/teacher: School 2, H
Date gathered: 18/06/2007

Description and contents

Copy – activity

‘Faces; activity where students work out possible outcomes of face types given specific attributes.

Importance of document

One group worked independently on a ‘faces; activity where students work out different possible outcomes of face types using given variables, e.g. curl hair, straight hair.
FACES

1. Here is a face.
   The eyes are open.
   The mouth is happy.
   The hair is curly.

   Now both eyes are open
   but they could be closed
   The mouth is happy
   but it could be sad
   The hair is curly
   but it could be straight

   It is possible to make twelve different faces by combining these features in different ways.
   Can you draw them all?

2. The face can be different again.
   The mouth can be happy
   or sad
   They eyes can
   look straight ahead
   or look to the right
   or look to the left
   The hair can be parted in the middle
   or brushed back

   Can you draw twelve different faces this time?

Copy of the faces activity
Appendix N  Worksheet activity-fractions: Helen

Document / artifact Summary Form

Site/teacher: School 2, H
Date gathered: 18/06/2007

Description and contents

Copy – activity

A fractions activity where students find fractions that are the same and different

Importance of document

One group of students worked on a fractions activity, where the students identified fractions marked on shapes that were the same or different, initially with the teacher and then independently once they had a grasp of the task. The teacher had sourced this task from the Mathematics Continuum provided online by the Victorian Department of Education and Early Childhood Development. The activity can be found at http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/numb er/N25001P.htm#3
Activity 1: What is the same and what is different?

Copy of the same and different fractions activity.
Appendix O  Teacher focus group: Helen

Document / artifact Summary Form

Site/teacher: School 2, H
Date gathered: 18/06/2007

Description and contents

Photos – students working on mat on task with teacher in teacher focus group.

Importance of document

Though students worked on a task with the teacher providing guidance as required they were generally working on the tasks independently for most of the lesson.

*Student working on “shape fractions’ independently using earphones to hear the voice-overs.*
Appendix P  Classroom organisation: Helen

Document / artifact Summary Form

Site/teacher:  School 2, H
Date gathered:  18/06/2007

Description and contents

Photos – student use of learning objects

Most students worked independently on learning objects.

Importance of document

Most students worked independently on learning objects but some provided peer support for other students where help was needed with reading on-screen text or with the actual task.

The teacher reported she liked being able to give students on different levels learning objects that looked the same because the students felt happy because they were doing the” same work as the other kids”. 
Student working on “shape fractions’ independently using earphones to hear the voice-overs.
Appendix Q  Student’s work samples: Andrea

Document / artifact Summary Form

Site/teacher:  School 2, A
Date gathered:  18/06/2007

Description and contents

Photos – classroom display

Student work from previous activities related to the current unit of work was displayed around the classroom.

Importance of document

The teacher had planned for different groups to be working on different groups. Some works were completing tasks related to number operations and some were working on identifying shapes and the properties of shapes. Students work from a previous shape recognition activity was displayed around the room.
Activities which the students had completed earlier, but were related to the concepts currently being covered were displayed in the classroom.
Appendix R  Classroom organisation: Andrea

Document / artifact Summary Form

Site/teacher:  School 2, A
Date gathered:  18/06/2007

Description and contents

Photos – student use of learning objects

Two students worked independently on learning objects and where there were not enough computers two students worked as a pair.

Importance of document

Photos show students working on computers individually and two students working as a pair as there were not enough computers for one each. The teacher grouped the two students together as they work at a similar level.

Though the LOs tend to look the same visually the teacher had allocated different learning objects to different students. Most of the students are working on ordering numbers 30 – 50 but one student, who is less able in mathematics, is working on an LO ordering numbers 1 – 20.

Student working on ‘slushy sludger’ which they moved to after they had completed ‘number partner’ the original LO planned for this lesson. Slushy sludger provided practice on the language of likelihood which they had been working on previous to the current unit.
Appendix S  Non-digital game: Andrea

Document / artifact Summary Form

Site/teacher: School 2, A
Date gathered: 18/06/2007

Description and contents

Photos– activity

Some students who were not using the LOs were playing an addition dice game.

Importance of document

The students who were playing “Addition path” were working on the same concepts as covered in the number partner learning object.
One group played a game "addition path" in which they added two numbers together to move towards the finish of the game.
Appendix T  Non-digital activity: identifying shapes:
Andrea

Document / artifact Summary Form

Site/teacher: School 2, A
Date gathered: 18/06/2007

Description and contents

Copy – activity

Some students who were not using the LOs were completing an identifying shapes activity.

Importance of document

The students who were playing “identifying shapes” were not working on the same concepts as covered in the number partner learning object, rather they were covering different concepts being covered in the same unit of work.
IDENTIFYING SHAPES

1  Colour the T-shirts that have the same shapes as the first T-shirt.

2  Design your own T-shirts.

- circles
- rectangles
- triangles
- squares

Copy of the identifying shapes activities.
Appendix U  Group rotations organisation: Andrea

Document / artifact Summary Form

Date gathered: 18/06/2007

Description and contents

Photo – classroom organisation

Grouping information written on the blackboard

Importance of document

Information was written on the blackboard to advise students what the teacher had planned for their group for that lesson.
Grouping organisation as displayed on the blackboard at the front of the class to inform students what their group was working on.
Appendix V  Existing curriculum resources that incorporate learning objects

‘Units of work’ provided by the Ministry of Education through NZ Maths (http://www.nzmaths.co.nz)

Algebra Units of Work

Behind all the work on the nzmaths site is the assumption that the best learning and understanding is achieved by ensuring that the children are actively involved.

<table>
<thead>
<tr>
<th>Learning Sequence</th>
<th>Aspects included in the unit</th>
<th>Functions</th>
<th>Units of work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 (K0 1, 2, 3)</td>
<td>Copy a pattern and create the next element</td>
<td>✓</td>
<td>Pattern Makers</td>
</tr>
<tr>
<td></td>
<td>Example Link</td>
<td>✓</td>
<td>Shapes and Sources</td>
</tr>
<tr>
<td></td>
<td>Links to Learning Objects</td>
<td>✓</td>
<td>More Than Little Contracts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>Too in the Bed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>Place Patterns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>Coordinates Counting</td>
</tr>
<tr>
<td>Level 2 (K0 1, 2)</td>
<td>Predict relationship values by continuing the pattern with systematic counting</td>
<td>✓ ✓</td>
<td>The Three Trucks</td>
</tr>
<tr>
<td></td>
<td>Example Link</td>
<td>✓ ✓</td>
<td>Beads on Wheels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>Stairs and Staircases</td>
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<tr>
<td></td>
<td></td>
<td>✓</td>
<td>Quencher Mute</td>
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<tr>
<td></td>
<td></td>
<td>✓</td>
<td>Letter Patterns</td>
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<tr>
<td></td>
<td></td>
<td>✓</td>
<td>Subtracting Objects</td>
</tr>
<tr>
<td>Level 3 (K0 1, 2, 3, 4)</td>
<td>Predict relationship values using recursive methods e.g. table of numbers, numeric expression</td>
<td>✓ ✓</td>
<td>Hundreds of Patterns</td>
</tr>
<tr>
<td></td>
<td>Example Link</td>
<td>✓</td>
<td>Properties of Operations</td>
</tr>
<tr>
<td></td>
<td>Links to Learning Objects</td>
<td>✓</td>
<td>Building Patterns Constantly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
<td>Cubes and Cubes</td>
</tr>
</tbody>
</table>
‘Mathematics Programming Frameworks’ provided by the State of NSW, Mathematics K – 6 Programming support of Department of Education and Training
# Measurement: Area

This is not a total teaching program, it provides an overview of the continuum of learning for Area.

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<tr>
<th>Stage</th>
<th>Outcome/key ideas</th>
<th>Sample teaching/learning/working mathematically activities</th>
<th>Resources</th>
<th>Planned assessment</th>
<th>Links to other strands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Stage 1</td>
<td>MES1.2 Describes area using everyday language and compares areas using direct comparison</td>
<td>Closed and open Using lengths of string or ribbon, students make lines and then shapes with the material and draw these shapes. Students indicate that area is the space enclosed by the boundary. Students can join several lengths to make a large area. Students then measure the area, in bodies, by lying down within the shape. (pp. 56–57 <em>Teaching Measurement ES1 and S1</em>)</td>
<td>Mathematics K–6 syllabus p. 96</td>
<td>Task: Identification of the attribute Students are given four small pieces of paper which are all the same shape but different sizes. Students select two shapes, compare by superimposing, and discuss which shape has the larger or smaller area. The shapes are pasted on paper and students label which shape has the largest and smallest area. (p. 55 <em>Teaching measurement ES1 and S1</em>)</td>
<td>Length concepts should be introduced before Area.</td>
</tr>
</tbody>
</table>
|         | Key ideas Identify and describe the attribute of area                              | Find a bigger area Students are given a piece of paper and they have to find three items with an area that is bigger, smaller or about the same size. Teacher models how to compare the area by superimposing. (p. 55 *Teaching measurement ES1 and S1*) | Mathematics K–6 sample units of work pp. 27–29 Teaching measurement Early Stage 1 and Stage 1 pp. 54–61 | Assessment strategy The teacher:  
- observes students superimposing shapes and using area vocabulary: surface, inside, outside, shape, area, boundary, large area, small area.  
- analyses student work |                        |
|         | Estimate the larger of two areas and compare using direct comparison                | Shoe-prints Students work in small groups to trace each student's shoe on paper and cut these out. They superimpose the shoe-prints to find who has the largest or smallest shoe-print and explain how they found out. Place the shoe-prints in order by comparing the area. (p. 58 *Teaching measurement ES1 and S1*) |                                                                                           | Assessment criteria The student:  
- superimposes shapes to compare size  
- indicates largest and smallest area.  
- orders shapes according to area. Work samples  
Task: Identification of the attribute Students order two or more areas by direct comparison. Who has the largest handprint? (pp. 60–61 *Teaching measurement ES1 and S1*) |                        |
|         | Record comparisons informally                                                      |                                                                                           |                                                                                           |                                                                                     |                        |


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http://www.curticulumsupport.education.nsw.gov.au

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</tr>
</thead>
</table>
| 1     | MS1.2 Estimates, measures, compares and records areas using informal units | **How will I cover?**  
Students choose units (tessellating and non-tessellating) from a collection to cover a shape. Discuss the suitability of the units, in terms of no gaps or overlaps. Draw and describe how the shape was covered.  
(p. 62 Teaching measurement ES1 and S1) | **Mathematics**  
K–6 syllabus  
p. 97  
**Mathematics**  
K–6 sample units of work  
pp. 69 – 72  
**Teaching measurement**  
Early Stage 1 and Stage 1  
pp. 62–80  
**DENS Stage 2**  
pp. 118–121, 218–221, 294–297  
**The learning federation mathematics learning objects.** http://www.tle.edu.au | (Assessment CD) Provide pairs of students with three different cardboard shapes. Students take turns to first estimate the order of the shapes according to area. Students then share strategies for measuring the area of each shape. (Movie)  
**How will I cover?**  
(p. 62 Teaching measurement ES1 and S1)  
Work samples |
|       | **Key ideas** Use appropriate informal units to estimate and measure area | **Stick construction**  
Students make shapes with 12 sticks (of equal length). They find which shape has the largest area bycovering with tiles (the sides of the tiles must be the same length as the sticks).  
(pp. 68–69 Teaching measurement ES1 and S1) | **The learning federation mathematics learning objects.** http://www.tle.edu.au | **How many more?**  
(p. 70 Teaching measurement ES1 and S1, BLM p. 78)  
Work samples |
|       | **Compare and order two or more areas** | **Which is bigger?**  
Using a 10cm x 10cm tile, students compare the areas of two rectangles taped on the floor or cut from cardboard. Students record and explain their measurements, the results of the comparison, and the pattern of repeated units.  
(pp. 72–73 Teaching measurement ES1 and S1) | Log in as a primary teacher, type in your user name and password. Select Search tools, primary teachers and type in the name of the learning object using the | **Which is larger?**  
Given two shapes on the opposite sides of a piece of paper (so they cannot be directly compared) students have to work out which figure is larger. Students record the number of units used to measure each shape and draw the array pattern of repeated units.  
(p. 96 Teaching measurement ES1 and S1) |
|       | **Record measurements by referring to the number and type of informal units used** | **Learning objects:**  
Students use The learning federation learning objects Area counting with Coco and Finding the area of rectangles to measure the area of rectangles. |  | **Assessment strategy**  
The teacher:  
- observes student completing the task  
- discusses estimation strategy with the student.  
**Assessment criteria**  
The student: |

Links to other strands:
- Length concepts should be introduced before Area.
- Fractions: Use parts of a unit to cover an area, e.g. half a tile, a quarter of a tile.
- Multiplication and division: Cover areas using an array structure and calculate the number of units e.g. counting by multiple units (see lesson “Roll the die twice”, Teaching measurement ES1 and S1 p. 63)
<table>
<thead>
<tr>
<th>Stage</th>
<th>Outcome/key ideas</th>
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<th>Resources</th>
<th>Planned assessment</th>
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</tr>
</thead>
</table>
|       |                  | **Hidden squares** Students are shown a square grid with a large rectangular shape superimposed on it. The shape is covered in tiles that are an integral multiple of the units on the square grid. Students have to work out how many small units are hidden and record their working. (p. 75 Teaching measurement ES1 and S1, BLM p. 80) | **Advanced search** (located at the top right hand side of the screen) | - chooses identical units to cover each area  
- estimates the larger area and explains the estimation strategy  
- states that the larger area has more units  
- draws an array pattern without gaps or overlaps.  
Work samples |  |
<p>|       |                  | <strong>The tiler learning object can be used for this activity.</strong> | | |  |
|       |                  | <strong>Tile roller</strong> Students roll the die and collect the corresponding number of tiles to form a row. The student then rolls the die a second time to indicate the number of rows to repeat. The student determines and records the total number of tiles needed. Encourage students to count in multiples. Have students verify by either making the array with the tiles or drawing the pattern on grid paper and counting. (p. 118 Developing efficient numeracy strategies Stage 2) | | |  |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Stage 2</td>
<td>MS2.2 Estimates, measures, compares and records the areas of surfaces in square centimetres and square metres</td>
<td><strong>Learning object:</strong> Students use The learning federation learning object The array which is a tool that allows students to create arrays to learn their basic multiplication facts. <strong>How do I know?</strong> (This activity differs from the Tile rover in that students place the rectangles onto the grid paper.) Provide students with a variety of cardboard rectangles and a sheet of grid paper. Have the students place the rectangles on top of the grid paper and use the grid structure to determine the total number of units covered by the rectangle. Have students share their results with others and explain how they determined the total. Discuss with students why grid paper is useful for measuring. (pp. 215-217 Developing efficient numeracy strategies Stage 2)</td>
<td>Mathematics K–6 syllabus p. 98 Mathematics K–6 sample units of work pp. 109–112 Teaching measurement Early Stage 1 and Stage 1 pp. 54-67 DENS Stage 2 pp. 216–217, 298–303 The learning federation mathematics learning objects (refer to Stage 1 for directions on how to access the learning objects) PowerPoint – Consistent teacher judgement in Mathematics for more Stage 2 work samples in Area.</td>
<td><strong>Calculating area in square centimetres</strong> Provide students with rectangles from the lesson How do I know? Students use a 1 cm grid overlay to calculate the area of the rectangles. Students record and explain how they worked out the area. <strong>Length x Breadth</strong> Students use 1 cm grid paper to draw different rectangles, each with an area of 24 square centimetres. Students label the lengths of the sides in centimetres and discuss the relationship between the lengths of the sides and the area of the rectangles. The investigation can be extended by considering areas such as 36 cm², 20 cm², or students' own choices. Some students may wish to experiment with fractional units. (p. 62 Teaching measurement Stage 2 and Stage 3)</td>
<td>Length concepts should be introduced before Area Fractions: Use parts of a unit to draw an area, e.g. half a square unit. Multiplication and division: Co-ordinate units to calculate the area. Link understanding of multiplication facts when forming arrays and calculating area. Use knowledge of factors to calculate the area e.g. 1 x 24, 2 x 12, 3 x 8, 4 x 6.</td>
</tr>
</tbody>
</table>

SW Department of Education and Training
Mathematics K–6 Programming support

Version published 15/9/06

http://www.curriculumsupport.education.nsw.gov.au
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<tbody>
<tr>
<td></td>
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<td>$5.00 per square centimetre. Extension: Find the total area of the numerals in a telephone number by drawing the numbers on 1 cm grid paper. Use the patterns from calculator numbers to draw. Find the total in square centimetres and record. (p. 59 Teaching measurement Stage 2 and Stage 3)</td>
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<td><strong>Make a square metre</strong> Teacher outlines a square metre on the floor with chalk or masking tape. Students discuss the length of each side and predict what the area of the shape would be called. Several students are asked to place 10cm square tiles in rows starting at one side. The class estimates, then counts how many will fit along each side. The class discusses how many tiles will be needed to cover the square metre, and how many square centimetres this would be. Individual students record the array of tiles and label with length and area measurements. (pp. 56–57 Teaching measurement Stage 2 and Stage 3)</td>
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<td><strong>Constructing a square metre</strong> In groups, students make a one square metre model out of newspaper sheets taped together. (p. 111 Mathematics K–6 sample units of work, Board of Studies)</td>
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<td><strong>Hopscotch</strong> Students in pairs make a 50cm square and discuss how many will be needed to make 1 square metre. Using the 50cm x 50cm tile, students design a hopscotch grid that has a maximum total area of three square metres. (p. 58 Teaching measurement Stage 2 and Stage 3)</td>
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</tbody>
</table>

**Planned assessment**
- uses knowledge of factors to justify answers
- explains the relationship between length and breadth and area of rectangles
Work samples

**Estimate a square metre**
(p. 54 Teaching measurement Stage 2 and Stage 3)

![Diagram](image)

We had to get 4 pieces of matchsticks and glue them together. It had to be one metre one way and one metre the other way. Then we had to stick it together to make a square metre. This is what it looks like.

**Measuring area in the playground**
Students measure defined areas in the playground using the paper square metre templates. Record the measurements and the array. Allow for ‘left over’ area when measuring with the square metre. Students check the measured dimensions of the area with a trundle wheel or tape measure. (p. 59 Teaching measurement Stage 2 and Stage 3)
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>MS3.2 Selects and uses the appropriate unit to calculate area, including the area of squares, rectangles and triangles</td>
<td>The tiler: The tiler can be used to strengthen the idea of area multiplication and the related change of units. The need to change units is a common feature of area conversion questions e.g. How many square tiles of width 10cm would be needed to tile a floor 2m long and 1m wide?</td>
<td>Mathematics K–6 syllabus p. 99</td>
<td>Length x Breadth</td>
<td>Multiplication and Division: use knowledge of multiplication facts and mental computation strategies to solve area tasks. Use knowledge of factors to calculate the area of a rectangle e.g.</td>
</tr>
<tr>
<td></td>
<td>Key ideas</td>
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<tr>
<td></td>
<td>Select and use the appropriate unit to calculate area</td>
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<tr>
<td></td>
<td>Recognise the need for square kilometres and hectares</td>
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<td></td>
<td>Develop formulae in words for finding area of squares,</td>
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<td></td>
<td>Bits and pieces: Students work with a partner to use two or three cardboard templates of different rectangles and squares to make a composite shape. Students trace around the outline of the composite shape and mark and label the lengths of all sides on 1 cm grid paper. Students swap their drawing with another pair of students, who must find the area of the composite shape from the given dimensions. Students check their answer by comparing with the areas of the cardboard templates. (p. 67 Teaching measurement Stage 2 and Stage 3)</td>
<td>Mathematics K–6 syllabus p. 99</td>
<td>Length x Breadth</td>
<td>Multiplication and Division: use knowledge of multiplication facts and mental computation strategies to solve area tasks. Use knowledge of factors to calculate the area of a rectangle e.g.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Using MSPowerPoint to draw rectangles on a grid</td>
<td></td>
<td>Teaching measurement Stage 2 and Stage 3 pp. 66–77</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Select a blank PowerPoint presentation. Select view on the menu bar, grid and guides. Tick snap objects to grid, and display grid on screen. Change the spacing to 1cm. Using the drawing tools, students can create shapes and</td>
<td></td>
<td>Talking about patterns and algebra p. 137</td>
<td></td>
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<tr>
<td></td>
<td>The learning federation mathematics learning objects</td>
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<td>Length x Breadth</td>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rectangles and triangles</td>
<td>record the areas e.g. draw rectangles that have an area of 24 square centimetres. (Refer to handout for further instructions)</td>
<td></td>
<td>area. Students explain the relationship between length, breadth and area. (p. 67 Teaching measurement Stage 2 and Stage 3)</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>Area sequences</td>
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<td>Set students the task of drawing the series of rectangles: 1cm x 8cm, 2cm x 8cm, 3cm x 8cm, 4cm x 8cm, 5cm x 8cm. Ask students to record the areas of the rectangles as a sequence, describe the sequence and look for patterns. Ask students to draw another series of rectangles involving fractions or decimals such as the following: 1cm x 3.5cm, 2cm x 3.5cm, 3cm x 3.5cm. Discuss: How would you describe this sequence of multiples? (p. 137 Talking about patterns and algebra)</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Comparing perimeter and area of rectangles</td>
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<td>Using a 4 metre piece of string, a group of selected students are asked to form a rectangle. They then make a different rectangle. Discuss that there can be many different rectangles for a given perimeter. Task: students use grid paper to draw rectangles with a perimeter of 20 centimetres and note the area each time.</td>
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<td>Cut and compare</td>
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<td>Pairs or individual students commence by taking a rectangle such as an A4 sheet of paper or smaller. Students draw and cut along one diagonal and investigate whether the two triangles which have been made are the same size. Students continue with different-sized rectangles to see if they can find a rectangle where the two triangles are not the same. Students select one of their rectangles and use</td>
</tr>
</tbody>
</table>

Decimals: Draw and construct shapes that involve decimals and calculate the area.

Fractions: Draw and construct shapes that involve fractional units and calculate the area.
the area of the rectangle to calculate the area of each triangle. As a whole class discuss how to find the area of a right-angled triangle.
(p. 68–69 Teaching measurement Stage 2 and Stage 3)

Investigation
Provide student worksheets to students in sequence. Students work with a partner to investigate the relationship of the triangle to the rectangle. Students write in words how they can find the area of any triangle.
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Learning object</strong></td>
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<tr>
<td></td>
<td></td>
<td>Students use the learning object <em>Area of triangles</em> to calculate the area of a variety of triangles.</td>
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<td></td>
<td><strong>Believe it or not!</strong></td>
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<tr>
<td></td>
<td></td>
<td>How many Year 5 or Year 6 students could stand, shoulder to shoulder, in a square hectare?</td>
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<tr>
<td></td>
<td></td>
<td>How many Year 5 or Year 6 students could stand, shoulder to shoulder, in a square kilometre?</td>
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<tr>
<td></td>
<td></td>
<td>Extension: if the world’s population was standing shoulder to shoulder, what area would be covered?</td>
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<td><em>(p. 70 Teaching measurement Stage 2 and Stage 3)</em></td>
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</tbody>
</table>
‘Resource lists’ and ‘Differentiated unit plans’ provided by The Mathematical Association of Victoria
TRIAL MATERIAL
WORK IN PROGRESS

Differentiated plans for Years 5 & 6
for
Algebra

Ian Lowe, MAV Professional Officer, 2006

IF YOU USE ANY OF THIS
PLEASE PROVIDE FEEDBACK TO IAN AT
ilowe@mav.vic.edu.au

THIS WILL QUALIFY YOU
FOR AN IMPROVED VERSION
WHEN AVAILABLE

Materials are recommendations only; suitable substitutions may be made.
MAV materials may be bought from www.mav.vic.edu.au/shop
Download the Curriculum Corporation catalogue from
and look at pages 48 and 49.
For Learning Federation materials (Learning Objects),
check out ‘Digital Learning Resources’ on your laptop, or download them from the new education website
Differentiated plans for Years 5 & 6

Algebra

Ian Lowe, MAV Professional Officer, 2006

Algebra concepts and skills are the language of higher mathematics. They start through developing ideas of number pattern, from Standard 3. The basic idea is the use of symbols to represent generalisations of patterns.

So extra effort is required to create a rich learning environment that can help children to understand and to achieve at their own level. This topic can be given 3 weeks in Years 5 and 6.

This set of units – one per semester for Years 5 & 6 – could achieve this goal. It matches the specifications for VELS, but recognises that there will be a wide spread of achievement in each class. So children are differentiated into working groups by need, for some of the time only. There may be more than one group at any Standard, or some Standards may need to be combined. Plan a stimulating set of activities for homework review, such as Interactive Learning spreadsheets.

It also balances the toolbox requirements – concepts and skills – with the need to learn to apply those tools in problem solving situations. Hence there are whole class lessons (often from Maths300 or RIME) punctuating the toolbox development, at regular intervals. These are on the same topic, but do not attempt to mesh with the work done by each ‘standard’ group. They ensure that Working Mathematically is always part of the learning process, integrated into each dimension.

The mix of activities will provide a stimulating and rich learning environment, with students learning from and helping one another. Connections between topics will be made and reinforced, and the variety of learning styles will accommodate learners with different needs.

How does it work?

In Years 5 and 6 it is assumed that children will be working anywhere from Standard 2 to Standard 5. Probably most will be working on Standards 3 or 4.

At regular intervals whole class lessons are taught to ‘mixed ability’ groups.

Between these are cycles of a fixed pattern of lessons. In Years 5 and 6, the cycle has three parts: teaching, worksheet or games, computer use.

On any day all are taking place in the same classroom, so only a fraction of the resources are needed. But the cycle also works for the students: they follow the pattern – teaching, worksheet, (problem solving) and computer. As a consequence, teaching is to a different group each day in a regular pattern. Teaching will be for a concentrated 20 minutes or so, and then the teacher will supervise the rest of the class. Instructions on the board will inform the other groups of what they are to do. Encourage students to help each other.

What resources are needed?

Access to 4 or 5 computers daily is expected. Computer pods or laptop trolleys might be the best solution. Membership of Maths300 is a requirement; many schools have membership – here is how to use it.

The pages in the resources are listed for each day’s lesson, but are summarised here. Sources are:

MAV (Mathematical Association of Victoria), CC (Curriculum Corporation), LF (Learning Federation).

• Teaching: Maths Continuum (DoE), People count (MAV)
• Worksheets: Active Learning 1 (N&A), Active Learning 2 (N&A) (both MAV),
• Computer: Interactive Learning (MAV), Learning Objects (LF)
• Problem solving: Maths300 (CC), Problem Solving Task Centre (CC), RIME (MAV), RIME 505 (MAV)

How could it be adapted to different situations?

If your class does not have the range predicted, or you cannot manage three or four groups, you should adapt by ignoring columns. You may substitute other learning tasks at any time. If you run out of time, leave stuff out. In this rich environment you will be surprised how much is learned outside the ‘planned’ activities.

How do I assess the learning?

At the end of the tables are sets of questions based on understanding at each VELS standard that will allow you to place children into groups and monitor progress at selected times. However your observations, digital photographs and copies of children’s work will be more useful than any external ‘test’.
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<tr>
<th>Yr 5 sem 1 Std 3 group(s)</th>
<th>Towards Std 4 group(s)</th>
<th>Towards Std 5 group(s)</th>
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<td><strong>Computer</strong></td>
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<td>0 Learning to Write a Report, 51 Stairs, 82 Snail Trail, 108 How Many Squares, 18 Ice-cream Flavours, 137 Training For Maths, 141 Flags From A Ship, 145 Land Of ET, 149 A Stacking Problem, 163 Pizza Toppings, 168 Antimagnets 1, 221 Triangles &amp; Colours</td>
<td>Interactive Learning</td>
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<td>Number patterns - describe and extend</td>
<td>People count #83</td>
<td>Graph stories, Walking, Filling bottles, One-day cricket, Table tennis, Tennis, Learning Objects</td>
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<td>People count #83</td>
<td>Continuum 4.0 Rules for sequences</td>
<td>Musical number patterns, Hopper, Circus Tower, Bridge-builder,</td>
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<td><strong>Problem Solving Task Centre</strong></td>
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<td>Recursive rules in words</td>
<td>0 Addition Totals, 11 Lining Up, 38 The Mushroom Hunt, 45 Eric The Sheep, 65 Shape Algebra, 71 Algebra Through Geometry, 111 Square Numbers, 146 Time For Tiling, 147 Roman Race, 150 Painted Red, 154 Four-Arm Shapes, 159 Mirror Patterns 2, 166 Sphinx, 173 Crossing The River 1, 178 Match Triangles, 179 Unseen Triangles, 181 Pointy Fences, 220 Smooth Edge Tiles</td>
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<td><strong>Worksheet / hands-on</strong></td>
<td><strong>Teach linear functions in words, tables and graphs</strong></td>
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<td>Hopper, Circus Tower, Bridge-builder</td>
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<td>A5 Adding neighbour numbers</td>
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<td>A1 Arranging trapezium tables,</td>
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<td>Finding a linear rule, Match shapes, Recursion graphs,</td>
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<td>Form and solve equations (symbols)</td>
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<td>Active Learning 1 (N&amp;A)&lt;br&gt;A10 Growth graphs&lt;br&gt;Active Learning 2 (N&amp;A)</td>
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<td>7</td>
<td>MCTP p195 Bingo bodies</td>
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<td>Teach solve simple equations by trial and error&lt;br&gt;People count #6</td>
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<td>Worksheet / games&lt;br&gt;Active Learning 2 (N&amp;A)&lt;br&gt;Quickmaths Algebra N-P, U-X</td>
<td>Teach&lt;br&gt;Formulas in words&lt;br&gt;People count #6&lt;br&gt;Active Learning 2 (N&amp;A)&lt;br&gt;Quickmaths Algebra F-M</td>
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<td>10</td>
<td>MCTP p277 Think of a number</td>
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<td>Worksheet / hands-on&lt;br&gt;Active Learning 1 (N&amp;A)&lt;br&gt;A36 Odds, evens and powers of 2, A27 Walking and running</td>
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<td>Teach solving equations by trial and error&lt;br&gt;People count #6&lt;br&gt;Active Learning 1 (N&amp;A)&lt;br&gt;A25 Pyramid puzzles,&lt;br&gt;Active Learning 2 (N&amp;A)&lt;br&gt;Quickmaths Algebra U-X</td>
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<td>Towards Std 4 group(s)</td>
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</table>

**Worksheet / hands-on**

**Active Learning 1 (N&A)**

A15 Stretching a rubber band

Active Learning 2 (N&A)

Quickmaths Algebra H-J

**Teach**

Number patterns - describe and extend

People count #53

Active Learning 1 (N&A)

All Multiply puzzles

**Computer**

Interactive Learning

Tickets, Step size – lines

Learning Objects

Musical number patterns, Hopper, Circus Tower, Bridge builder

**Problem Solving Task Centre**

51 Starcase, 62 Snake Trail

108 How Many Squares? 116 Ice-cream Flavours, 137 Training For Maths, 141

Flags From A Ship, 145 Land Of ET, 149 A Stacking Problem, 153 Pizza Toppings, 168 Airships 1, 22 Triangles & Colours

**Teach**

Recursive rules in words

People count #52

Continuum 4.3 Rules for sequences

**Problem Solving Task Centre**

8 Addition Totals, 11 Lining Up, 38 The Mushroom Hunt, 46 Eric The Sheep, 65 Shape Algebra, 71 Algebra Through Geometry, 117 Square Numbers, 140 Time For Tilling, 147 Garden Beds, 152 Painted Roots, 154 Four-Arm Shapes, 159 Mirror Patterns 2, 166 Sphinx, 173 Crossing The River 1, 176 Match Triangles, 179 Unseen Triangles, 181 Pointy Fences, 220 Smooth Edge Tiles

**Worksheet / games**

Active Learning 2 (N&A)

Quickmaths Algebra A-M

**Teach**

Linear functions in symbols, tables and graphs

People count #67

Continuum 4.25 Meaning of letters in algebra

4.5 Structure of algebraic expressions

Active Learning 1 (N&A)

All Picture patterns

**Problem Solving Task Centre**

2 Cars In A Garage, 5 Make A Snake, 10 Find My Pattern, 27 Can Slack, 28 Play Triangles, 44 Lath Sqaures, 48 How Many Triangles? 68 Thirty-one, 102 Crazy Animals

**Computer**

Interactive Learning

Step size – lines, Square numbers, Match shapes, Recursion graphs

Learning Objects

Musical number patterns, Hopper, Circus Tower, Bridge builder

**Worksheet / hands-on**

Active Learning 1 (N&A)

A21 Borders of triangles

**Teach**

Number sentences – form in words and complete

People count #80

Active Learning 1 (N&A)

A24 The three circles puzzle

**Problem Solving Task Centre**

See Std 4 lesson 2

**Computer**

Interactive Learning

Think-number puzzles

Three-circles puzzle, Match shapes, Recursion graphs

Learning Objects

Make puzzle, Lifting loads, Bridge builder

**Worksheet / hands-on**

Active Learning 1 (N&A)

A25 Pyramid puzzles

Active Learning 2 (N&A)

Quickmaths Algebra U-X

**Teach**

Form and solve equations (Intro to symbols)

People count #15

Continuum 4.25 Meaning of letters in algebra

4.5 Structure of algebraic expressions

Active Learning 1 (N&A)

A23 The three circles puzzle

**Problem Solving Task Centre**

See Std 5 lesson 3
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<td><strong>Think-number puzzles, Three-circles puzzle, Learning Objects</strong></td>
<td><strong>A24 Solving with graphs</strong></td>
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<td><strong>See Std 3 lesson 6</strong></td>
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<td><strong>Maths300 #57 Crazy Animals 2 of 2</strong></td>
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<tr>
<td>5</td>
<td><strong>Computer</strong> Interactive Learning Finding a linear rule, Formula guessing, Graph guessing, Learning Objects Musical number patterns</td>
<td><strong>Worksheet / hands-on</strong> Active Learning 1 (N&amp;A) A29 A big stretch</td>
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<td></td>
<td><strong>Teach</strong> Quadratic functions People count #55 Active Learning 1 (N&amp;A) A10 Cutting the pie Active Learning 2 (N&amp;A) Quickmaths Algebra Z.</td>
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<td>6</td>
<td><strong>Problem Solving Task Centre</strong> 2 Cars In A Garage, 5 Make A Snake, 10 Find My Pattern, 27 Can Stack, 26 Plate Triangles, 44 Latin Squares, 48 How Many Triangles? 60 Thirty-one, 102 Crazy Animals</td>
<td><strong>Computer</strong> Interactive Learning Quadratic graphs, Tickets, Graph guessing, Learning Objects Filling glasses</td>
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<td><strong>Worksheet / hands-on</strong> Active Learning 1 (N&amp;A) A17 More patterns Active Learning 2 (N&amp;A) A7 Quadratic patterns</td>
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<td>7</td>
<td><strong>Maths300 #25 Sphinx 1 of 3</strong></td>
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<tr>
<td>8</td>
<td><strong>Teach forming and completing number sentences</strong> People count #55 Active Learning 1 (N&amp;A) A26 More puzzles Active Learning 2 (N&amp;A) Quickmaths Algebra U-X</td>
<td><strong>Problem Solving Task Centre</strong> See Std 4 lesson 2</td>
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<td></td>
<td><strong>Computer</strong> Interactive Learning Step size – curves, Square numbers, Triangle numbers, Quadratic graphs, Ball toss, Parabolas Learning Objects Mobile phones, Lifting loads, Bridge builder</td>
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<tr>
<td>9</td>
<td><strong>Worksheet / hands-on</strong> Active Learning 1 (N&amp;A) AS Adding neighbour numbers</td>
<td><strong>Teach</strong> Form and solve equations (symbols) by trial and error People count #65 Continuum 4.5 Structure of algebraic expressions Active Learning 2 (N&amp;A) Quickmaths Algebra U-X Active Learning 1 (N&amp;A) A26 More puzzles</td>
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<td><strong>Problem Solving Task Centre</strong> See Std 5 lesson 3</td>
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<td>10</td>
<td><strong>Maths300 #25 Sphinx 2 of 3</strong></td>
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<tr>
<td>11</td>
<td><strong>Computer</strong> Interactive Learning Match shapes, Guess and check, Backtracking, Learning Objects Musical number patterns</td>
<td><strong>Worksheet / hands-on</strong> Active Learning 1 (N&amp;A) A26 More puzzles</td>
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<td><strong>Teach</strong> Solving linear equations using inverses Doing the same to both sides’ People count #66 Continuum 5 &amp; 6 Conceptual unit for solving equations</td>
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<tr>
<td>12</td>
<td><strong>Problem Solving Task Centre</strong> See Std 3 lesson 6</td>
<td><strong>Computer</strong> Interactive Learning Guess and check, Quadratic graphs, Tickets, Graph guessing, Learning Objects Hopper, Circus Tower</td>
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<td><strong>Worksheet / hands-on</strong> Active Learning 1 (N&amp;A) A61 Solving equations from graphs</td>
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<td>13</td>
<td><strong>Maths300 #25 Sphinx 3 of 3</strong></td>
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<td>Yr 6 Sem 2 Std 3 group(s)</td>
<td>Towards Std 4 group(s)</td>
<td>Towards Std 5 group(s)</td>
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<td>14 Teach More number patterns &amp; equations People count #66 Continuum 4.0 Rules for sequences Active Learning 1 (N&amp;A) A34 Volume and surface area of prisms Active Learning 2 (N&amp;A) Quickmaths Algebra Cdt</td>
<td><strong>Problem Solving Task Centre</strong> See Std 4 lesson 2</td>
<td><strong>Computer</strong> Interactive Learning Equivalent equations, Learning Objects Squirt, Hopjar</td>
</tr>
<tr>
<td>15 <strong>Worksheet / hands-on</strong> Active Learning 1 (N&amp;A) A6 Picture patterns,</td>
<td><strong>Teach</strong> Linear functions People count #67 Continuum 4.5 Structure of algebraic expressions Active Learning 2 (N&amp;A) Linear algebra: x, y, a, b, d, d, a, d Active Learning 1 (N&amp;A) A34 Volume and surface area of prisms</td>
<td><strong>Problem Solving Task Centre</strong> See Std 5 lesson 3</td>
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<tr>
<td>16</td>
<td><strong>RIME A6 Consecutive numbers</strong></td>
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Rowe, L.

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