Explorations of the Moral Socio-Cultural Contexts of the Intentional Action of Physics Teachers, Case Studies to Inform Practice and Teacher Education

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Submitted in total fulfilment of the requirements of the degree of Doctor of Philosophy

October 2017
Melbourne Graduate School of Education
The University of Melbourne
Abstract

This study seeks to explore the intelligibility of physics teaching and the dynamics of the processes of personal professional identity formation processes. The teachers’ reflections in association with their vision, motivation, understanding and practice in their daily discursive practices have been carefully explored from multiple semi-structured conversational interviews and classroom observations.

In this study I attend to the situational, cultural and social identities of ten physics teachers, at different stages of their careers; student teachers in training, early career and experienced teachers, in their autobiographical accounts, analysing their subject positions as classifications, participant roles, viewpoints and interactive positions in their schools and beyond.

Positioning theory has been used to locate the agency of the teachers in their accounts of dynamic social episodes, and to deeply explore the complexity of the multiplicities of their social realities, evidenced in their discursive practices, that is in their alignment of both their “doings and sayings”. Pronoun Grammar Analysis (PGA) has been utilised to better locate the teacher as agent, in their own positioning in their own storylines and the social impact claimed for them. The use of PGA has assisted in illuminating and interpreting the teachers’ “technologies of the self”, against the local cover, secret and sacred stories.

The teachers’ storylines seemed to be consistently impacted upon and influenced by the teachers’ institutional setting and also by past and present members of their school communities of practices. The teachers explained what they “do” and clearly described their understanding of their duties, as those that were imposed upon them in the concrete local social context of teaching in general, and of physics teaching specifically. They discussed how they had come to make practical sense of what physics teaching meant to them in their own classroom, but at the same time, also how their teaching had come to be adapted to how teaching was already being performed, and valued in their schools.

There are many ways in which to approach and analyse the identities that emerge and unfold in research materials. In this study the teachers’ identities have been approached as historically, socially and culturally produced positions, as processes that are in
permanent state of becoming. This study has found, and suggests that we need more complex ways to better understand the multiple “ways of being” that are required to be an effective teacher in school setting generally, and particularly as a physics teacher. The study has general implications not only for a richer study of identity formation of physics teachers but also the use of narrative accounts presented in the case studies in the study for pre-service programmes and faculty development.
Declaration

This is to certify that:

- the thesis comprises only my original work towards the PhD except where indicated in the Preface,
- due acknowledgement has been made in the text to all other material used,
- the thesis is fewer than 100 000 words in length, exclusive of tables, maps, bibliographies and appendices

Signature: [Signature]

Date: 18/04/2018
Acknowledgments

Bismillahir Rahmannir Rahim
(In the name of Allah, the most Gracious, the most Merciful)

First and foremost, my sincerest and deepest gratitude is certainly to Allah the Almighty for the endless blessings and for making my life journey a beautiful one to experience.

I would also like to express my sincere thanks and heartiest gratitude to the following for their support during the research and writing of this thesis:

My supervisors, Dr Christine Redman and Dr Pamela Mulhall for their endless input, time, patience and friendship. I am very privileged to have had the opportunity to learn from my two wonderful supervisors and to receive their support that gave me strength to go on and complete this thesis.

Dr Rod Fawns, for his endless efforts, critical feedback, encouragement, advice and genuine concern for the development of my thesis.

Dr Gerry Healy and Professor David Clarke, my advisory committee members who throughout the years have provided valuable insights and advice to further improve the thesis.

All the members of Rod Fawn’s Doctoral group, The Ginger Group, who have made invaluable comments in our weekly meetings over the years. All the members of Christine Redman’s Doctoral group, The Luminaries Group and all the members of Professor David Clarke’s research group, who helped me gain multiple perspectives about doing research.

All the 10 participating teachers for their very welcoming voluntary participation and time for the interviews and welcoming me into their classrooms. This study was made possible by the interest and commitment to the project by all these 10 teachers.
My wonderful husband, **Bismil** and my three sons, **Irfaan, Zafraan and Afnaan**, my beloved parents, **Haji Mohd Said** and **Hajah Rahmah** and all my **family members** for their continuous prayers, support, love, encouragement and understanding over the years.

A special thanks to all **my friends and colleagues** who have helped me in many ways and shared their experiences with me to keep me going.

And last but not least, my sincere thanks to the Brunei Government of His Majesty **Sultan Haji Hassanal Bolkiah** and Yang DiPertuan of Brunei Darussalam for my scholarship to pursue my study at the University of Melbourne.
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Chapter 1  Introduction to the Study

“By a series of common-sense constructs [people] have pre-selected and pre-interpreted this world which they experience as the reality of their daily lives” (Schutz, 1954, p. 267).

1.1 Introduction

My interest in this study emerged partly from my work experience in my home country, Brunei, during the preparation and training of science and physics teachers. My interest also arose from my concern with student teachers’ practice in schools which often did not, in any way, reflect the expectations of the teacher education programmes. My concern was supported by the literature, which further encouraged me to do this study. Specifically, I wanted to better understand why teachers “do what they do” and how they rationalised their acts and actions in terms of their social, psychological and social psychological positioning in physics teaching.

A key assumption in this study is that teachers join teacher education as prospective physics teachers with knowledge, perceptions and beliefs previously shaped by social representations in discursive practices in which they have engaged in and which are rooted in their biographies. After participating in various discipline discourses in school and undergraduate university classes as well as conversational realities outside, the intelligibility of physics and science teaching that develops is both gradually transformed and reproduced during teacher training and involvement in professional practice. Shulman’s (1987a) Pedagogical Content Knowledge (PCK) is often taken as a generic categorical framework that usefully extends and distinguishes aspects of teachers’ knowledge that is related to teaching specific subject matter, from that of the discipline knowledge per se. However, this study seeks a deeper and more comprehensive account of the processes of a physics teacher’s personal agency and identity formation. It is anticipated that a more profound understanding, both in their practical epistemology and moral craft, will be found in teachers’ collective sense of their practice,. This understanding can be reached through exploration of the social orders and social motivations in their discussion of mediating material and symbolic entities in their everyday teaching (Harré, 2002).
1.2 Aims of this Study

This study explores physics teacher’s identity formation by exploring the moral career of the participating teachers and their sense of oughtness. The sense of oughtness is the sense of what they perceive as right and should be done within their community. Hence, this study seeks to explore how teachers discursively position (Davies & Harré, 1990; Harré & van Langenhøve, 1999) themselves through their uses of technologies of the self (Foucault, 1988) and others, in the contexts of their schools, with their students and in different discursive communities of practice in their schools. This study aims to gain better knowledge and research on how the agency of the physics teacher develops and functions.

Schatzki’s (2002) “timespace” practice or site-based social ontology is examined in this study of physics teachers’ everyday lives. This is exploring the teachers’ practical intelligence in performing, identifying and responding in particular situations to particular actions, applying rather than following rules (Bailyn, 2002). This is by looking at how they employ a series of explanation of teleoffective structures (Schatzki, 2002, 2005). These explanations draw on general understandings linked to shared beliefs, goals or values incorporated in structures and orders shared with significant others as social representations (Jovchelovitch, 1996).

1.3 Background of the Study

1.3.1 Context of this Study

This study has been undertaken in Melbourne, Victoria, Australia, where, to some degree, exists a different cultural context than that in my own country, Brunei Darussalam as well as in Leeds, United Kingdom where I had done my research previously (Haji Mohd Said, 2007). Brunei has adapted its education system based on the British model, in particular, at the senior levels (see Appendix 1). During the seventies and nineties, developments and challenges in physics teaching and education in each of the three countries mentioned above have been influenced by attempts, particularly at structural reform of senior physics teaching through examinations, new curricula and associated texts (Gunstone, 2004; Hart, 2001, 2002; Tiberghien, Jossem, & Barojas, 1998; Woolnough, 1994). A total of ten Australian physics teachers participated in this study; two were still in training (pre-service), four were in the early part of their career and four were experienced teachers.
The teachers were encouraged to reflect on and discuss their perceptions of their daily discursive behaviours. These physics teachers provided accounts, examples and rationales for their practices with a view to describe any significant changes which had influenced, informed or constrained their self-improvement or agency. There is a wider significance and value in the ethogenic approach (see key term in section 1.8) in this study for future teacher education and development of teaching practice. This is particularly significant in countries which share narrative curricular traditions, referencing tasks and tool formats, established conventions and informal customs in teaching that constitute key elements in the practical intelligibility of physics teaching.

1.3.2 The Pilot Study

A pilot study informed the refinement of the design of this research. Modifications emerged through the processes of undertaking and reflecting on the insights of preliminary explorations with three teachers. These preliminary insights into the social orders that shaped teachers’ agency had thereby informed the construction of the research interviews. The changes these teachers perceived from their early years of teaching did not entirely meet my early assumption that the teachers’ accounts would emphasise the influence of subject knowledge and curriculum prescription. Interview questions were refined with the use of Personal Meaning Mapping (PMM) (discussed later in the methodology chapter) to support the teachers’ efforts to share what they wanted to say (Falk & Dierking, 2002; Falk, Moussouri, & Coulson, 1998; Giardiello, Parr, McLeod, & Redman, 2014; Rennie, Feher, Dierking, & Falk, 2003) and to give an early overview of the meaning of the teachers’ work life space.

1.4 Research Questions

The following research questions were framed as a result of my interest and experience in science and physics teacher preparatory training, a broad review of the relevant field of contemporary literature as well as preliminary discussions with competent university and school educators:

- What personal and social meanings do the participating teachers attribute to their practice as a physics teacher?
• How do the teachers position and reposition themselves in their accounts of their practice, in relation to the norms of senior physics teaching and, more generally teaching in their schools and beyond?

• How do these teachers describe the processes which have contributed to their professional identity formation as physics teachers?

1.5 Challenges and Concerns in Physics Teacher Education

In addition to what I intended to find out through the research questions, this study is also conducted with the evolvement of research in science and physics education and physics teacher education together with the advances and contributions of technologies in learning and teaching. Physics is often recognised to be different from other sciences in the degree of its abstraction and idealisation (Duit, Niedderer, & Schecker, 2007; Ford, 1989; Vicentini & Sassi, 2008; Woolnough, 1994). Duit, Niedderer and Schecker (2007) indicated from a European perspective three major contributions to higher education that are expected of secondary level physics education: a contribution to general education, the development in students’ scientific thinking and providing an epistemological foundation for learning at the tertiary level. While they observe that the European view puts more focus on the acquisition of scientific knowledge itself, rather than to the formation of students’ commitment, the Americans adhere to a pragmatic and optimistic view of the public recognition of science as a means for social progress in order to achieve students’ commitment in secondary schools. In Australia, the physics curriculum released by Australian Curriculum Assessment and Reporting Authority (ACARA, 2013) indicates that one of the rationales of the physics curriculum is to enable students to become better informed and more skilful citizens relative to the world around them.

The above rationales in physics education are similar to the following five concerns listed on what science education attempts to achieve as described almost for a quarter of century by Ogborn, cited in Osborne (1990). Ogborn described:

1. The world as observed by science and to present an ontology of the physical world
2. ‘How things work’ to provide causal explanations
3. Introduce the skills, techniques and processes that form the methodology and vocabulary of the scientist
4. Interpret and translate the scientific information in order for students to understand significance or lack of significance attached to scientific statements.

5. Present the science knowledge to the context, relevance and have some utility for students.

However, Osborne (1990) indicated these perspectives for physics education have generated a sense of dissatisfaction and are unappealing to most students. Physics in schools is often taught according to students’ level of understanding which adequately allow them to explain how things work and this might gives inappropriate and misleading perspectives of the scientist’s worldview to school children. In addition, there was a shortage of well-qualified science teachers who were experts in the subject and who could inspire their students through their enthusiastic and competent teaching as well as through personal conversations and encouragement (Woolnough, 1994).

More than a decade later, a similar kind of issue was still observed by Duit et. al., (2007). The complexity of the influences and parameters of everyday world phenomenon is hugely reduced by physicists, in order to make quantitative predictions possible. The reduction and reconstruction of this experienced world and conversational realities under the abstracted assumptions of the disciplinary discourse of physics, they argue, has made learning physics difficult for students and a persistent challenge for physics teachers. This challenge is made more difficult when teachers use non discursive teaching approaches which are often neither embedded in a narrative of enquiry into the nature of the disciplinary discourse of physicists as an historical and cultural enterprise nor are they grounded in students’ motivation to understand material causes of everyday social phenomena. Research has indicated that school physics teaching often emphasises the transmission of formulaic definitions of concepts to solve standard physics problems even when teachers have constructivist view of learning (Linder, 1992; Osborne, 1990; Tobin, McRobbie, & Anderson, 1997). Furthermore, the research consistently argues that traditional approaches fail the students and the public in their appreciation of the narrative of physics as one of the greatest achievements of the human imagination.

A more recent report by Meltzer and his colleagues (2012) in the USA National Task Force on Teacher Education in Physics observed that their nation needs more school teachers who themselves have a strong background in physics. A similar concern was raised by Woolnough in the nineties. To understand physics is to understand its concepts,
principles and processes as well as views of its nature and logical order of reasoning. In order to meet this officially, the report indicates a heightened focus on identifying and developing physics teachers’ knowledge, skills, and dispositions in education programmes is necessary. Reports in Australia (Tytler, 2007) and Europe (HLG, 2004) suggest a focus on the need to reimagine the nature of the physics curriculum in schools as to engage students with meaningful learning. Similar concern was pointed more than two decades ago by Osborne (1990) who suggested that prior to any attempt to change the physics education, a rationale for why we teach physics needed to be discussed first in order to consider what is appropriate to the process of cultural transmission in the teaching and learning of physics. However, this attempt is unlikely to bear much fruit if those who seek to exercise authority over curriculum prescription and teaching practices ignore teacher ontologies. As indicated by Tobin and McRobbie (1996), it is first necessary to attempt to understand why teachers “do what they do” and “who is doing, what with what and to whom and why” in their accounts. Hence, teachers’ agency through their discursive positioning in their stories and conversations, in institutional practices and societal rhetoric is attempted to be explored in this study.

1.6 Key Elements Informing this Study Design

Teachers are often assumed to construct and reconstruct their identity through their practical epistemological reasoning (Anderson, Kahl, Glass, & Smith, 1983; Barnett & Hodson, 2001; Beck, Czerniak, & Lumpe, 2000; Helms, 1998; Smagorinsky, Cook, Moore, Jackson, & Fry, 2004). Smagorinsky and his colleagues (2004) pointed to the implications for teachers’ efficacy and wellbeing when teachers try to adapt to the expectations of a school culture, which is at odds with their teacher training.

Shulman’s Pedagogical Content Knowledge (PCK) (1986) has provided a popular agenda for researchers seeking to identify both the essential knowledge to accomplish individual teaching in different subject areas, and a framework for teacher’s appraisal and teacher education programmes across all social settings. Theories of reflexivity in the social sciences have primarily been concerned with the way individuals monitor their own actions, using knowledge of the social context (Giddens, 1984) or deliberate on the social context to make choices through the internal conversation (Archer, 2003). The internal conversation looks into social conditioning and individual’s social mobility which then
allows to link between society and the individual, structure and agency. Yet, little emphasis has been placed on the teleoffect; a term which Schatzki (2002, 2005) refers to a range of “normativized” ends, projects and tasks which allied with “normativized” emotions and even moods. There is also minimum link between an individual agency and place or site-based ontologies at the centre of reflexivity (Schatzki, 2002). In the same way, Schutz (1932) showed how an individual’s action can be thoroughly embedded and directed by cultural structures and schemes. A teacher learns what “to do” based on what is required when orientating to the rules and norms of the local moral order (Harré & van Langenhøve, 1999) of their time and place of employment in their use of available resources or approaches, particularly to the newly introduced fields of physics teaching. These often require discursive psychological repositioning of both their agency and that of their habitus, including colleagues.

Heiskala (2011) referred to Peirce (1931–58) who made a four-fold distinction between four habits that might be observed in individual physics teachers’ accounts of physics teaching. There are habitual actions, habits of interpretation, habits of belief (everyday knowledge) and veritable belief (knowledge). Habits of interpretation and habits of belief are often fused in social phenomenological research (Heiskala, 2011) but the tension between them in the teachers’ accounts is a focus in this research. There is a need to explore the tension between the revealed local moral order, or institutional order, of a school to show how a teacher’s identity and agency are reproduced and transformed. This is represented by teachers’ narratives of their ideal intended and actual physics/science curriculum in their and others’ institutional practices. This is especially true in periods when the school curriculum is changed in response to the change in perceptions of advances in the subject discipline, social needs, educational priorities and examination, and textbook reforms. At the interface between private and public worlds, teachers’ purposes and social necessity, as well as personal and professional identities are transformed. In addition, institutions are re-organised in everyday discursive practice.

In this sense, the study adopts an ethogenic approach. Better descriptions of a teacher's habits of interpretation and habits of belief (Heiskala, 2011), that underpin existing practices of physics teachers at different phases in their career and in different school contexts, could inform attempts to support and improve professional practice through teacher education policy and programmes. This can be achieved by investigating
teachers’ beliefs about their competing duties and responsibilities which are associated with their professional actions when facing intended, initiated and sustained social change. Hence, this study explores, beyond teachers’ general beliefs, how different knowledge have influenced and shaped an emergent practical understanding. These teacher’s doings and sayings (Burkitt, 2002; Harré & van Langenhøve, 1999; Schatzki, 2002) are explored to better understand how their agency or identity is influenced by the social orders or norms of physics teaching.

Teachers can be encouraged by research such as the current study to retain the ability to see themselves for what they are and what they may become, by resisting a condition Bullough (2008a) describes as “social facticity”, and Harré (2009) describes as “substantivalism”. Bullough (2008a) suggests that to avoid the “social facticity”, researchers need to consider that “Every life is culturally and historically inscribed…to understand teachers and their lives is to understand both troubles and issues, biography and history” (p. 18). This is in agreement with Harré (2009) who argues that in the social world, people are the fundamental agents where their actions and activities are carried by their social representations. Thus, I am interested to explore and describe how the relationships between specified kinds of knowledge, of being, space and time, could shape teachers’ habits of action, of interpretation and of beliefs. According to Jovchelovitch (1996):

“it is by engaging in debates [about such relationships] that our [research and professional] practices can become objects of reflexivity and [when] underpinning elements can be [expressed]. Furthermore, inquiries about everyday practices and knowledges, the constructed character of human experience and the relationship between the subject and [his or] her society are not restricted to social [psychological research]. In approaching such fundamental questions we are also transcending disciplinary boundaries and contributing to a much needed dialogue [between human] and social sciences [in science education research]” (p. 121).

1.7 Structure of the Thesis

The first part of Chapter 2 presents a brief review of adapting phenomenological study in this research in order to better interpret the teachers’ accounts of their positioning and repositioning in their institutional practices and societal rhetoric. Consequently, the second part of the Chapter 2 reports on and gives careful consideration to the published research in science and physics teaching. This focus relates, in particular, to teachers’
beliefs, knowledge, practices and agency referencing broader social and cultural policy settings, as these have often been the focus in these kind of research rather than the site-based ontologies of the teachers and their formation.

In Chapter 3, the research design and methodology, as well as the purposes for employing a phenomenological process, are discussed. Often, teachers are busy with teaching thus have little time, opportunity or expectation to talk about why they do things the way they do. Teachers and researchers are often said to belong to different cultures and moreover, being from another social culture, I had several boundaries to cross in order to sustain this research. I selected data gathering tools which aligned with methods that aimed to generate discussion that, in turn, would bring teachers stories and experiences forward.

Chapters 4 and 5 present the teachers’ accounts and the conversational analysis. Chapter 4 presents the positions of the experienced teachers while Chapter 5 is focused on the early career and pre-service teachers. The chapters are organised under four commonly referenced elements of teachers’ reflection made determinant by pronoun grammar analysis (Mühlhäusler & Harré, 1990a; Redman & Fawns, 2010). This is followed by general discussion of the findings in Chapter 6 while the final Chapter 7 discusses the implications of this study for research and professional practice in physics education.

1.8 Key Terms and Related Concepts

Certain key words and phrases used throughout this thesis are introduced here and developed in the context of their use later. The following terms and concepts assist in establishing boundaries and ways to better understand the over-arching theories and terms used in the literature.

**Teachers’ Identities and their Transformation**

The common characteristics of identity as commonly documented in the literature and summarised below by Luehmann (2007, p. 827) are used in this thesis:

- “Identity is socially constituted as a result of interactions one has with others, one is recognised as a type of person by oneself and others
- Identity is formed and reformed constantly where the change processes for one’s core identities evolves over a period of time
• Identity of a person becomes identifiable and recognised as a result of a number of interrelated ways and a range of different types of participation in social communities
• Identity is constituted in interpretations and narrations of experiences” (p.827).

In this research, teachers’ identities, both personal and professional are intimately related and developed in the interaction of public and private psychological spaces. This development occurs in different social situations, at the interface of their intentions and social necessities, norms or expectations which collectively describe the teacher's local moral order.

**Perceptions and Beliefs**

Some teachers may use the word “perception” interchangeably with the word “belief”. This can also be associated or analogous to other words such as attitude, values as well as internal mental strategies, personal theories and conceptual systems (Pajares, 1992).

In this present study teachers’ perceptions are understood to cover their beliefs, values, attitudes and moral or norm-referenced stances in relation to particular propositional knowledge that is to be taught to their students. Their perceptions encompass what they deem to be “good” physics teaching and learning in their classroom and other's classrooms is a social construct (Mulhall & Gunstone, 2008). More specifically in this study, what teachers perceive or claim to believe about their own teaching or others, in relation to their positions in their community of practice and their habits of belief, is taken to be in tension with their habits of interpretation.

**Communities of practice**

According to Wenger (1998), “communities of practice” are communities that share the kind of meaningful practice, formally or informally. A person’s identity is revealed and constructed in the practices, both discursive and non-discursive which a person adopts. In this study, there are at least two communities of practice or discursive norm circles (Elder-Vass, 2010). They are i) the community of science teaching colleagues in their schools and ii) the community of physics education in universities and schools which attributes causal power to the discourse of teachers.
Discursive practices

Discursive practices refer to what people *do* and *say*. These practices encompass local and daily individual particular positioning, institutional practices and societal rhetoric; refer to the choices and actions the teachers make in their teaching practices in their own local context (Harré & van Langenhøve, 1999). This local context subsumes one’s own school as well as system related schools that are usually taken into account when a teacher is considering norms of standardised and acceptable practice within their community of practice. Hence, the local context relates to the norms of physics teaching in a particular community of practice. The study of everyday discursive practices acknowledges the dynamic nature of the choices teachers make, and that the influences of organisations including examination authorities, schools and norm circles on teacher’s choices can be complex (Redman, 2008).

Norms and Norm Circles of Physics Teaching

Norms in this study shape the mental life of the participating teachers that occurs within their own space of reasons studied in dialectical arguments about their purposes, social expectations, duties and responsibilities typically cited as shared knowledge or social representations (Brinkmann, 2006; Jovchelovitch, 1996). This study includes social representations of what physics teaching is expected to be for, and how judgments can be made about competence and performance. For there to be a correct or competent use of words and signs, and judgment about these, a norm must be part of a shared form of life which “specify ends and purposes, stipulate forms of activity and [will also] inform how objects and events can be used in pursuit of particular ends and purposes” (Schatzki, 2010a, p.152).

Social Representations

Being in the social world of schools, teachers present “social representations [as] a network of mediating social meanings” (Jovchelovitch, 1996, p.125) as how their identity is carried. These representations are symbolic representations formed between teachers and their community and society which intertwine with the process of identity construction (Jovchelovitch, 1996). The representations also include affection and everyday knowledge and experience.
Ethogenic Approach

Ethogenic approach is concerned with research which attempts to understand individuals’ actions and to link them with understandings of the individuals’ social world through their speech and language. To do this, this study requires a socio-psychological perspective by which sociological and psychological dimensions of teaching are brought together (Harré, 1993, 2002). A psychological perspective allows for the discursive actions of teachers to be focused on and analysed, whereas, a sociological stance allows better understanding of an individual’s social life in a given society and culture. The sociological perspective as indicated by Harré involved at least two social orders: the practical order, that is, the organisation of work and the expressive order, that is, the organisation of status and honour.

Positioning theory

Positioning theory (Davies & Harré, 1990; Harré & van Langenhøve, 1999) is used as an alternative to role theory (Parsons, 1951). It is an analytical tool that allows a better understanding of teachers’ social behaviour by focusing on teachers’ discursive practices, their speech and actions and their interpretation of their rights and duties as members of their local communities. The local moral order results in how people take and act out their interpretations of their rights and duties in their own institutions. van Langenhøve and Harré (1999) propose that “the social world is created…within [everyday] conversation, [where] social acts and societal icons are generated and reproduced” (p.15). Within the storyline shared by the participating teachers in their conversations, their position is jointly constructed and determines their social acts. Figure 1.1 illustrates the elements in the analysis of research conversations conducted with the teachers to understand their identity formation.

Figure 1.1: Mutually determining triad (van Langenhøve and Harré, 1999)
The concept of storylines refers to the narrative or stories that the teachers used in a conversational interaction to describe their actions in words that are meaningful not only to themselves but also to others (van Langenhøve & Harré, 1999). The relevant storylines “can be taken from a cultural repertoire or can be invented” (van Langenhøve & Harré, 1999, p. 30). Within the storyline, a person’s characteristics act as a point of reference to their positions which may change accordingly depending on how people perceive and construct meaning to the storylines of their interactions.
Chapter 2  Literature Review

"Teachers are faced with many problems and dilemmas; they have their own interests and beliefs; yet they are at the centre of a number of competing values and ideologies; they are situated within a network of inter-relationships and expectations" (Woods, 1996, p. 29).

2.1 Introduction to Interpreting Teachers' Meaning Making

Physics teaching is examined in this study as a social act. This is reflected in Jovchelovitch’s discussion of the idea of “space”. She indicates that “the social is a space of institutional boundaries and limits. Yet, these limits are not absolute. For, the social is also a space where possibilities are proposed, a space of communication and a space where self and other meet” (Jovchelovitch, 1996). Within Schutzian phenomenology, in this study, the social is taken to generate the dynamics of the classroom, the school, disciplinary knowledge as well as “historical, political and economic elements” (Jovchelovitch, 1996, p. 123) which restrict what may supposedly enablers of teaching. In the “conversational” space of their practice, researched in this study, others’ identities are likely to be explored by the teachers, local moral orders acknowledged and publicly revered. This resonate with Jovchelovitch’s argument that “the social is also a space for transcending boundaries and instituting new ones” (Jovchelovitch, 1996, p. 123). Teaching is studied as a social act practiced in the conversational reality of classrooms, schools and society and within a disciplinary discourse and beyond.

This study has an interest in generative structures, both personal and cultural, as well as social interactive structures underlying science teaching, in particular, the social nature of physics teaching. Since recent structural-functional research (as will be discussed further in section 2.2) has increasingly emphasised the importance of the personal agency of the science teacher, this study sought to explore fundamental structures of intent or agency among a number of Australian physics teachers at various stages in their careers. This study, which investigated the practical intelligibility of physics teaching, may have broad applicability within a critical perspective of the culture of science education and teacher education in my country, Brunei Darussalam which shares some British curricular and research traditions (see Appendix 1), including the published aims of science education, with that of Australia.
Brinkmann (2006) following Wittgenstein indicates that the differences in people provide a platform to understand the various reasons underpinning why they act in particular manners. When actions are articulated with justifications, Brinkmann (2006) in agreement with Schatzki (2002) and Harré (1993) observes that often people act reasonably without being “rational”. For them practice precedes action. In a sense, it is having a practical reason for action consciously present “before the mind’s eye”. Brinkman elaborates that the normative reasons for action, feeling and thought that in this study that I am faced with aspects of the world of the teachers’ social practices and semiotic interactions.

This research adopts a phenomenological approach to the study of the practical intelligibility of physics teaching. Heiskala (2011) indicates that

“phenomenological sociology has an individual mind as its point of departure, it deals with problems characteristic to action theory, it pays a great deal of attention to [the] cultural maps and schemes which define the environment of action to the actor, and it does not understand culture as a uniform code subordinating the subjects but emphasises instead cultural variation between the actors” (p. 231).

Hence, in this study, the “actors” are the teachers where their experiences and practical meanings and their related development are explored. In phenomenology, meaning is knowledge. In phenomenological sociology, meaning is everyday knowledge. Heiskala (2011, p. 233) argues, quoting Schutz, that

“Meaning does not lie in the experience [as such]. Rather, those experiences are meaningful which are grasped reflectively. The meaning is the way in which the Ego regards its experience. The meaning lies in the attitude of the Ego toward that part of its stream of consciousness which has already flowed by, towards its ‘elapsed duration’” (Schutz, 193, p. 69-70; original emphasis).

Meaning, Schutz argues, can be associated with motives and can be seen as being constructed either as a retrospective reflective accounting or as a practical future-oriented direction and expectation of the everyday life-world. Heiskala (2011) distinguishes the "because" and "in-order-to" motives schematically in Figures 2.1 and 2.2 below. Schutz calls the “in-order-to” or project motive, a pragmatic orientation to the future whereas a “because” motive attributed to themselves or others in hindsight, by selecting out certain features of the situation, as it was before the action in question, and then regards these features as the reasons for the action. In the “in-order-to” motive, as the “actors”, they can explain themselves in terms of their own or collaboratively constituted meanings in
projects portrayed below in Figure 2.1, as reflective intentional acts presented directed in point \( t_1 \) to Ego’s intentional act in point \( t_2 \).

In the “because” motive, the action is explained by reference to the past and prior established purpose, which is either of personal meaning or of cultural meaning. This “because” motive as in Figure 2.2 is “directed in point \( t_2 \) to the Ego’s intentional act in point \( t_1 \)” (Heiskala, 2011, p. 234).

![Figure 2.1: Project or “in-order-to” motive as a reflective intentional act (Heiskala, 2011, p. 234).](image1)

![Figure 2.2: “Because” motive or interpretation of meaning as an individual reflective intentional act (Heiskala, 2011, p. 234).](image2)

Hence, this study is concerned with the physics teachers' accounts of their personal agency embedded in their practices embodying their everyday representational and relational use of language to engage their students in the disciplinary discourse of physics as well as the conversational realities of everyday physics teaching and learning. In this study, the consciousness of daily life is a social consciousness which takes for granted the practices of other physics teachers, as inhabitants of the same world, their reactions and assumed knowledge as inhabitants of the same world and their use. Schutz (1932) describes this social consciousness as typification, abstractions and standardisations. These mutual symbols, in practice, are created and communicated among community members in the intersubjective world of shared meaning: a historically given world they share or aspire to join. The self-typification presented by the physics teachers in their accounts of their practices, Schutz suggests, will be influenced by processes of acculturation or socialisation. It is through these two processes that they come to construct
patterns of motives and ends, characteristic attitudes and personalities. These processes may not enable them to know other physics teachers as individuals but become motives for their own actions and enable cooperation in discursive and non-discursive practice with other teachers of whom they have little or no personal knowledge.

In this study of using research conversations,

“the social representations [that the teachers present are taken as] forms of symbolic mediation firmly rooted in the public sphere. The public sphere - as a space of intersubjective reality - is the terrain in which they are generated, crystallised, [reproduced] and eventually transformed” (Jovchelovitch, 1996, p. 122).

The teachers’ social representations are seen as having a social genesis in their practices, discursive and non-discursive, which develop in a site-based ontology (Schatzki, 2002, 2003) of practice and function as part of social life guided by dual social orders of practice: the organisation of maintenance that is the practical order, and the organisation of honour that is the expressive order (Harré, 1993, 2002). Harré’s concept of human beings living in a double social order (2002) for the practical order concerns social arrangements for maintaining life in an environment or habitus a person is in whereas the expressive order concerns the creation of hierarchies of honour and status in social arrangements. In everyday practice, social acts and actions must be as much concerned with social maintenance as with transformation. A teacher's social representations are not performed as individual actions although they certainly enshrine individual experience (Jovchelovitch, 1996). Indeed the relationship between experience and personal meaning is an active exploration for the teacher and here it is studied as such.

2.2 Research into the Agency of Science Teachers

PISA (Programme for International Student Assessment) and TIMSS (Trends in Mathematics and Science Study) are examples of international comparative studies that are large scale government funded research which have assessed students’ competencies using standardised tests (Prenzel, Seidel, & Kobarg, 2012). These research measure the teaching of science in terms of “outcomes”. PISA 2006 used a contextual framework when examining the process of teaching and learning in science as a result of the findings on teaching effectiveness (OECD, 2006). The framework is said to provide comprehensive understanding into the link between students’ scientific literacy and the teaching and learning of science. However, these structural functional research tend to
offer view and description of science or physics teaching education as an “objective” reality of teaching and learning which might not take into account an individual perspective and his or her agency.

On the other hand, conducting phenomenological research may only describe what it is for physics teachers to “tell the code” and do little to explain how physics teaching came to be the way it is or how it may be changed. Hence, in this social phenomenological study, attention is maintained to the personal agency of the teacher and their local moral order. As Harré (1989) points out, a person has long been neglected in psychological research, an observation which could easily be made more specifically of cognitive psychological studies of science teaching or learning.

The rest of this chapter is presented in three sections related to the intelligibility of science and physics teaching. Three constructs have been employed in psychological studies of science teachers primarily in attempts to explain their different efficacies. Overviews of these areas of research are presented below. The first area to be presented is a review of the literature about teachers’ beliefs. The second area of research is teachers’ knowledge. The third area reviewed is of research in teacher identity. Each of these has commonplace meaning in the current study.

2.3 Review of Research on Teachers’ Belief

2.3.1 Teachers’ Beliefs through a Review of Literature

Research that aims to understand teachers’ practices has often found links between beliefs and instruction. Generally, teachers’ beliefs or dispositions are reflected and acted out in their pedagogical approaches, which are implemented into their teaching (Beck et al., 2000; Crawford, 2007; Cronin-Jones, 1991; Gunstone & White, 1998; Haney, Czerniak, & Lumpe, 1996; Kagan, 1992; Northcote, 2009; Tobin, Tippin, & Gallard, 1994). Teacher beliefs are often treated as dispositional or "how to" knowledge and held to reference ontologically significant reflexive episodes for that teacher, in which particular experiences, and past and present knowledge that a teacher holds about teaching are rationally aligned and can be accounted (Brousseau, Book, & Byers, 1988; Brousseau & Freedman, 1988; Crawford, 2007; Deemer, 2004; Fang, 1996; Gess-Newsome, 1999; Kagan, 1992; Nespor, 1987; Tobin et al., 1994).
Northcote (2009) found that the link between teachers’ beliefs and their teaching is most evident in terms of “teaching strategies, preparation methods, course design considerations, face-to-face interactions and assessment techniques” (p. 78). Northcote (2009) points out as teacher educator-researchers, “we should be aware of our own educational beliefs and [seek to] make them transparent to ourselves and to others” (p. 78). Northcote reports that being transparent to our own beliefs could assist in explaining, justifying, questioning and informing future educational practice. She also suggests that transparency to our own beliefs may provide teachers and students or both with what is generally expected of the aims and objectives of education to achieve better quality of teaching and learning.

Teachers’ beliefs are described as being grounded in their personal experiences and are highly resistant to change (Hoban, 2003; Kagan, 1992; Nespor, 1987; Pajares, 1992). Pajares (1992) states that beliefs teachers hold about particular situations can shape their attitudes and influence their perceptions and judgments which will then influence and impact on their behaviour in classrooms. Some researchers suggested these links were as a result of various factors, such as beliefs or influences or knowledge about content and pedagogy (Crawford, 2007; Hoban, 2003; Lederman, 1992; Löfström & Poom-Valickis, 2013; Sin, 2014; Thomson, Turner, & Nietfeld, 2012). Thomson and her colleagues (2012) in their study with prospective teachers in relation to their beliefs about teaching and school found a relationship and important role between motivation and beliefs in developing the direction of the teachers’ career as well as their approaches to teaching. This has led to suggestion by Thomson and her colleagues that teachers educators need to be well-informed and recognise the connections between teachers’ aims and beliefs of their practices.

Kagan (1992) and Pajares (1992) explain how teacher’s perceptions, judgments and behaviours are controlled by their belief systems. The belief systems inform a teacher’s own personalised pedagogy that forms and grows richer and more coherent as experiences in classrooms grow. Nespor (1987) and Pajares (1992) indicate beliefs can be defined as personal constructs. These personal constructs inform and influence teachers’ practices such as in making decisions about their teaching and for managing their classrooms. Kagan (1992) argues that belief is considered as teacher’s professional knowledge where he claims a belief is taken to be true from teacher’s experience. Kagan (1992) states that:
“A teacher’s knowledge of his or her profession is situated in three important ways: in context (it is related to specific groups of students), in content (it is related to particular academic material to be taught), and in person (it is embedded within the teacher’s unique belief system)” (p. 74).

Kagan’s above claim of a teacher’s knowledge situated in three ways is seen in the teachers’ description about their practices in this study as will be discussed in the findings chapters that the teachers described their discursive practices in relation to their own context, physics teaching and about themselves.

2.3.2 Teachers’ Beliefs and the Cognitive Models of Teaching Literature

Teachers’ beliefs, in relation to teaching instruction have been mainly categorised as traditional/conventional or constructivist/conceptual-change (Haney & McArthur, 2002). The conceptual-change focused student-centred classrooms have been supported by constructivist learning theory and are perceived by the researchers to epitomise the desired science teaching and learning approach (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Eick & Reed, 2002; Helms, 1998; Hewson & Thorley, 1989; Miyake, 2008; Scott, Asoko, & Driver, 1992; Volkmann & Anderson, 1998). This approach views student learning as a metacognitive process focused on conceptual change where the role of teachers is to employ student’s prior knowledge in the introduction of formal scientific knowledge. The metacognitive process of conceptual change is believed to be stimulated in classroom discussion in which students come to replace their own beliefs/knowledge with those of their teacher.

On the other hand, the conventional physics teaching approach is held not to involve metacognitive processing but to emphasise rote learning of formal often mathematical formulations of physical concepts and use of these formula to solve physics problems with little or no “feel” for engagement or with the ideas/concepts of physics (Linder, 1992; Mulhall & Gunstone, 2012; Osborne, 1990; Tobin, 1998; Tsai, 2002). Tsai (2002) argued that conventional teaching was motivated principally by the belief that the teacher's role was to transfer their knowledge to their students; also adding that student learning in this belief structure comprised of acquiring and reproducing knowledge from credible sources that are taken to provide correct answers or established truths. This positivistic belief structure has sedimented into established systems that emphasised in dealing with symbols in abstract contexts, and therefore, did not support or expect
teachers to psychologically locate their physics teaching in contexts familiar to students (Hart, 2001, 2002).

Hart’s (2001) study which attempted to enhance the Victorian Physics curriculum found that for curriculum innovations, the academic physicists are still impacted by the traditional science concepts that they hold on to. Teachers in the Australian Council for Educational Research (ACER) science forums (Tytler & Symington, 2006) emphasised that there was a requirement for school to have access to the institutional support of their community members and parents who are very likely to hold socially conservative perspectives about the nature of science and believe the social purpose of science teaching to be less concerned with the development of a student’s executive intelligence than with finding a place for them in the economic system. Further the institutional commitment to the improvement or in sustaining academic reputation of the school is often publicly indexed to student examination success, in mathematics and physics in particular, and is often cited as a key feature of a commitment to science teaching in its traditional forms. The “extrinsic” motivations of students and parents, who saw examination success as a ticket of entry to professions such as engineering, are often cited in moral defence of conventional teaching approaches. Considerable research suggests that these formulaic approaches rarely produce conceptually meaningful learning in physics that could enrich understanding of everyday phenomenon (Duit, Niedderer, & Schecker, 2007; Tytler, 2007).

2.3.3 Science Teachers’ Beliefs about Science Teaching

Bryan (2012) observed that research on science education has progressed to further expand explanations as to how practices are influenced by beliefs. However, research into science teachers’ beliefs and understandings has had many foci. These include teachers’ beliefs and their mastery in the content and nature of science, the curriculum, pedagogy, objectives of teaching and teacher education. Some research, which analysed the relationships between science teachers’ beliefs and their practices as well as teachers’ and students’ actions, found discrepancies between what were said with what were observed. What researchers found during classroom observations and data collection seemed to contradict to what was told (Brown & Melear, 2006; Eberle, 2008; Kang & Wallace, 2005; King, Shumow, & Lietz, 2001; Segal, 1998; Simmons et al., 1999; Water-Adams, 2006).
Kang and Wallace (2005) explained that in their study with three experienced secondary science teachers, the researchers found indistinct connections between the teachers’ practices when aligned with their sophisticated epistemological beliefs as stated in interviews. In their conclusion, Kang and Wallace (2005) indicated that teachers’ actions may not have direct links to their beliefs. Peirce's (1931-1958) four-fold philosophic and semiotic distinction between habits, habits of interpretation, habits of belief that are everyday knowledge and habits of true belief that are knowledge seems important to be considered here. Only rarely in this relatively recent research, like the one by Kang and Wallace in 2005 has the tension between teachers' habits of interpretation and their habits of belief been explored let alone maintained in studies of teacher’s beliefs.

Crawford (2007), for instance argued in her study of student teachers’ beliefs that teacher’s goals and capacities to teach enquiry based science was shaped by own individual personal beliefs about teaching and the nature of science. This included their beliefs and knowledge about pedagogy, schools, student learning and the nature of scientific inquiry. Over a year, she studied five prospective high school science teachers on their knowledge, thinking, views and attempts to “use the inquiry method of teaching” in their science classes. Crawford found that an entire spectrum of teaching strategies were practiced that ranged from traditional styles, lecture-kind of lessons, to comprehensive and inquiring type of investigative projects. A “positive link” was found between the teachers’ levels of subject knowledge and their personal commitment/belief in teaching science as inquiry. A higher level of subject knowledge was found to determine their professional belief in teaching by inquiry. The latter was indexed to the personal effort. The five teachers said they invested in teaching in this mode. They explained teaching science by inquiry provides positive outcomes with respect to the local moral order of the school. Crawford concluded that how a teacher answers to questions and inquiries of students might depend on a teacher's individual personal knowledge which more broadly defined after Shulman (1986) but understood not only in terms of what was known but how each was known and how each was valued in practice. These personal knowledge includes not only the scope and degree of knowledge of the teachers on science concepts but also “knowledge of pedagogical strategies, curriculum, children’s developmental level, children’s abilities to conduct investigations, how students interact in groups and of the school context” (Crawford, 2007, p. 616).
A similar point was discussed by Mansour (2009) following his review on research between teachers’ belief and practices. He found that the mediating factor was the gap between beliefs and practices. Mansour concluded that teachers’ beliefs are often context-bound where the social contexts were defined implicitly and determined the teachers’ choices in their works. He suggested that a better understanding on teachers’ beliefs and their works and actions could be obtained through teachers’ discussion of their classroom approaches as well as discussion of the school science textbook.

Research on physics teachers’ beliefs has been often focused on their teaching of junior science topics rather than in physics classes. This research has synthesised instrumental psychological “interactions” between physics teachers’ beliefs, attitudes, knowledge and teaching styles (Asikainen & Hirvon, 2010; Duit et al., 2007; Gunstone & White, 1998; Mulhall & Gunstone, 2008; Mulhall & Gunstone, 2012; Tobin et al., 1997). Much of the research has focused on both teachers’ and students’ poor general cognitive appreciation and understanding in particular domains of physics, and the need to adopt constructivist pedagogies to enhance conceptual understanding (Savinainen, Scott, & Viiri, 2005; Scott et al., 1992).

Teachers’ beliefs and attitudes about physics classroom practice are generally held to influence what teachers feel they should do in classrooms (Gunstone & White, 1998). However, a study done by Ogan-Bekiroglu and Akkoç (2009) found that two out of six of pre-service physics teachers displayed an inconsistent belief-practice relationship. The two teachers changed their practices in their school settings as a result of various constraints on the enactment of belief, which were related to judgments about student aptitudes and their personal context. The latter included a belief that they lacked the subject matter knowledge to put their constructivist beliefs into their teaching practices.

Mulhall and Gunstone (2008) found that most of the physics teachers they researched had given little thought to the nature of physics and physics knowledge, suggesting that physics teaching was generally impoverished by a lack of reflection by physics teachers on the history and philosophy of physics for learning and narrating physics. Mulhall and Gunstone (2012) found some differences in views about physics between teachers with different teaching approaches. Those embracing “conceptual teaching approaches”, as a mode of operation, tended to focus on students’ intellectual engagement with physics concepts. This the researchers identified with teacher reasoning that these approaches
allowed students to construct their own understanding from their own prior knowledge and to recognise and develop their understanding through their own real experiences in portraying the physics ideas in the forms of formulas, laws or models. The traditional approach tended to focus on mathematical and quantitative problems. Students’ successes are seen to depend not only on their interest but also on their competencies and commitment. Students are encouraged to do “problems” and laboratory work as learning is seen to take place from the experiences itself.

2.3.4 Teachers’ Beliefs and Culture

Culture in the context of this study, as indicated earlier, is concerned with both descriptive interactive experience and accounts of the emergence of the social meaning of physics teaching for these teachers in Melbourne schools. Researchers has increasingly claim for the need to incorporate the impact of culture when studying about teachers’ belief (Bryan, 2012; Hamilton, 1993; Hargreaves, 1980; Mansour, 2009). Bryan (2012) indicated that few studies on science teachers’ beliefs seem to have considered and/or addressed the sociocultural dimensions of science teachers’ beliefs. Mansour (2009) argues that as people explain their world and provide their perspectives of life on what is around them, their beliefs are shaped within their culture that play a role in deciding what they see as important to them. Mansour supported his argument on the need of doing research that look into cultural framework by referring to Olson (1988) who observed that “what teachers tell us about their practice is, most fundamentally, a reflection of their culture and cannot be properly understood without reference to that culture” (p. 69).

Mansour (2009) explains how the relationship experienced between beliefs and practices in many instances has restrictions and also occasions that are affected by external factors, materials and resources “such as the individual classroom, the school, the principal, the community, or the curriculum” (p. 32). This setting supports the practice theory which takes account of activities through an examination of a person’s sayings and doings in the particular time-geography (Pred, 1983). The social acts of teachers are informed by their agency in relation to the time and space they are in (Caldwell, 2012; Schatzki, 2000, 2003). The character and transformation of the social acts and life of the teachers in this study are considered in their site-based ontology (Schatzki, 2003).
Tobin and McRobbie (1996) certainly do not take cultural myths to be untruths, in suggesting cultural myths influence what a teacher decides makes sense, and what does not, in their classroom practice. They suggest a belief stated by a teacher, which refers to intuitive actions in teachers’ own social settings, can be seen to be a cultural myth. These myths, they argue, have been identified as obstacles to constructivist reform in science education to explain the persistence of privacy in traditional teaching practices. Based on Tobin and McRobbie’s study, four types of cultural myths were identified based on (p. 223):

- the transmission of myth in which a teacher acts as a principal source of knowledge and the students as receivers of knowledge,
- the myth of efficiency in which teachers have control over their students and content coverage being more important than students learning with understanding,
- the myth of rigour in which teachers are to act as guardians of disciplinary standards of the curriculum, and
- the myth of preparing students for success in examinations in which students are to learn how to answer examination type questions correctly.

The behaviours of parents, administrators, colleagues and students are seen by teachers to reinforce these myths. This led teachers to abandon their collaborative practices in student learning or with colleagues and to revert to traditional practices. Tobin and McRobbie (1996) argue these myths need to be made explicit to teachers. Research which explores why teachers do what they do through investigations of their beliefs and associated actions may help overcome these myths. Such phenomenological sociology may show how teacher action is comprehensively subsumed and led by the culture. The study of teachers' actions and habits of interpretation based on the influence of culture has to be considered and distinguished from their habits of belief and their habits of true belief (Heiskala, 2011) as taking into account of the differences could provide better account and understanding of teachers.

2.4 Review of Research on Teachers’ Knowledge

Russell (1993), one of a number of prominent physics teachers began in his writing about the future of teacher education and professional knowledge of teachers by quoting Stones:
“The delivery view of teaching is so prevalent in the English-speaking world today, in the language used about teaching as well as in much of its practice, that it is probably the greatest single obstacle to the development of a form of teaching fit for human beings. Closely linked to this view is the idea that on-the-job teacher training plus a modicum of theory is adequate to produce competent teachers” (Stones, 1992 cited in Russell, 1993, p. 205).

Clearly, research on the perspective of teachers’ knowledge need to be explored. Ben-Peretz (2011) reviewed papers over a period of 20 years from 1988 to 2009 in the Journal of Teaching and Teacher Education (TATE) that focused on the aspects of teachers’ knowledge indicated that the phrase teacher knowledge has been made more extensive. Ben-Peretz referred to Gorski’s work in 2009, that included global and societal issues such as multiculturalism in defining teachers’ knowledge in addition to general themes “such as subject knowledge, curriculum and pedagogical content knowledge” (Ben-Peretz, 2011, p. 8). Ben-Peretz argued that as the term teacher knowledge is used extensively, it is important to take into account the aspects of context and situations that also shape teacher knowledge. Generally, the concept of teacher knowledge targets on teachers’ main role in teaching their subject that allow them to conduct their roles with relevant principles and pedagogical skills.

Clandinin and Connelly (1996) claimed that teachers’ personal knowledge which comprised of their relationships with others, their work settings and other related circumstances can be understood by considering the contexts involved. They pointed out that when context questions are raised in education, they are always answered conditionally with “it depends” on the factors. They further indicated that the contexts for teachers' professional knowledge landscapes shape a person's stories about how individuals are positioned on that landscape. This is reflected on and discussed in this study when the teachers talk about their practice. The operation of these contextual factors can be understood only in teachers’ norm related practices, both discursive and non-discursive.

Russell and Martin (2007), in their review of published science education research, indicated that teaching for conceptual development and change has been dominant in that research. They indicated that although learning from experience was being recognised as an element of teachers’ professional development, the research into this element tended to be undervalued. Research on learning to teach science need to be explored by giving attention to narrative reasoning as well as teachers’ propositional knowledge (Bullough,
2008b; Bullough & Baughman, 1996; Russell & Martin, 2007; Woods, 1987). This is what this study attempts to do.

2.4.1 Teachers’ Subject Knowledge and Pedagogical Content Knowledge

Research in teacher knowledge has generally determined that teachers’ subject knowledge is specifically related to teaching practices in classroom (Gess-Newsome, 1999; Parker & Heywood, 2000; Richardson, 1996; Tobin et al., 1994). Teachers are usually expected to be skilful and knowledgeable in their content subject areas (Crawford, 2007; Gess-Newsome, 1999; Parker & Heywood, 2000; Tobin et al., 1994). Teachers’ teaching styles and actions have been found to be informed and influenced by their subject knowledge (Arzi & White, 2008; Asikainen & Hirvonen, 2010; Crawford, 2007; Traianou, 2006). Although teachers’ subject knowledge is not to be held as the sole determinant of why teachers do what they do, analysis of a teacher's propositional subject knowledge is generally felt to provide a window on teacher's dispositional knowledge that informs their practical knowledge of how to respond in any situation.

The importance of teachers’ subject knowledge in their teaching aligns with a study done by Richardson (1996). He identified two kinds of knowledge domains that affect not only teachers’ practices but also their understanding of teaching. The first domain refers to matters related to the subject and issues with the curriculum. It also accounts for successful way of delivering a lesson. The second domain relates to teachers’ principles of teaching which includes their understanding and reasoning to their actions and to what they take into accounts as good teaching in a classroom. This codification corresponds to Harré's (1993, 2002) dual social orders of practice and expression, which were informed by the writings of Thornstein Veblen in 1899 on “A theory of the leisure class”.

Roberts’ (1996) philosophical analysis of the epistemological authority of teachers' belief that their students have learnt, suggested an implicit model in Figure 2.3 of social constructivist teaching, in which teachers' and students' representations and constructions are mediated and transacted in science teaching within a disciplinary domain.
Figure 2.3: Robert’s triilogue model. Code: “R/E” = representation and/or explanation; “O” = observation(s); “HR” = by (others of) the Human Race; “S” = by the student (Roberts, 1996).

Traianou (2006) observed that studies of teacher knowledge have been generally grounded in an individualist cognitive psychology. She argued for a social constructivist research orientation, claiming that teachers’ misunderstandings often arose as a result of making inappropriate links between student experience and student knowledge or from their use of misleading everyday language. This was also identified by McDermott (1990), who found that in-depth subject knowledge does not necessarily make for better science explanations of students' everyday experiences, a position supported by Parker and Heywood (2000).

Arzi and White (2008), in their longitudinal study of exploring changes of teachers’ knowledge of subject they teach, found that the single most powerful influence in changing teachers’ knowledge was the required curriculum. The science content was taken for granted by the teachers and remained low in their “change list”. What the teachers learned as school students tended to shape their prior knowledge and interest for further learning. The current curriculum prioritised what the teachers wanted to know and how to achieve it. Arzi and White (2008) suggested the need for structural support for teachers in their subject knowledge growth and renewal over the long term. In Asikainen and Hirvonen’s (2010) study of six Finnish physics teachers' conceptions of teachers’ knowledge, it was revealed the teachers associated knowledge of physics with knowledge
of strategies and methods, that is with their purposes of engaging their students in the learning and required reasoning. Their more “phenomenologically informed research provides for a significant movement away from what Strauss and Quinn (1997) have characterized as the ‘mirror’ or ‘fax’ model of internalization that is prevalent in [learning] theory [and research]” (Throop & Murphy, 2002, p. 200).

Teachers’ content knowledge and their pedagogical knowledge influence each other (Shulman, 1987a). Teachers, Shulman argues, who possess an in-depth and detailed knowledge of their subject must be more effective in representing the subject to students. Others argue such teachers are likely to be more capable of posing questions and responding to students’ questions, of selecting tasks and evaluating their students’ understanding and also more capable of making curricular choices than teachers who are limited in their subject knowledge (Crawford, 2007; Eberle, 2008; Kennedy, 1998; McDiarmid, Ball, & Anderson, 1989). However, Eberle (2008) found that how the teacher holds and values specific knowledge in its wider conceptual associations in the subject domain and beyond, is likely to be important in teaching scientific reasoning.

Shulman (1987a) categorised teachers’ knowledge into three main categories: content knowledge, knowledge about pedagogy and Pedagogical Content Knowledge (PCK). Content knowledge refers to teachers’ levels of understanding of the subject that he or she is teaching. In physics, that includes knowledge of physics concepts and the relationships among them, as well as ways of acquiring the knowledge. Pedagogical knowledge refers to knowledge about teaching and learning theories. These include knowledge about brain development, knowledge of learning collaboratively and how to deal and manage a classroom and its discourses (Etkina, 2005, p. 3). Teachers are often assumed to have gained their subject content knowledge from their degree studies and are expected to develop their pedagogical knowledge from their teacher training. Thus, PCK concerns knowledge of appropriate strategies for teaching a given topic to a particular group of students.

Using Shulman’s (1986, 1987a) definitions of PCK, teachers do need to be informed and able to comprehend their subject knowledge as well as able to effectively give lesson on each concept in their subject. Experienced teachers, he observes are expected to be able to distinguish which concepts are more difficult for their students to understand. Such teachers should also to be able to respond, organise, sequence and present using prescient
metaphors, these ideas to students who have their own diverse interests and aptitudes. PCK was taken subsequently, by many researchers in teacher education, as the conception of the integrated knowledge, and also their beliefs and values about teaching (Gess-Newsome, 1999; Loughran, Mulhall, & Berry, 2004; Magnusson, Krajcik, & Borko, 1999). Referring specifically to physics, Etkina (2005) points out PCK consists of, but is not limited to, “knowledge of physics curriculum, knowledge of student difficulties, knowledge of effective instructional strategies for a particular concept, and knowledge of assessment methods” (2005, p. 3). For Etkina, PCK represents knowledge that teachers use to structure student experiences so that the students actively construct physics concepts.

Barnett and Hodson (2001) attempted to broaden the social psychological PCK of Shulman into a critical social framework of “pedagogical context knowledge”. Initially, Barnett and Hodson looked at the centrality of teacher knowledge and understanding. This was first described referencing the traditional forms of curriculum development pointing to what was expected from teachers, and the typical view of educational change which was independent of the social context. This notion of teaching was the basic function for teachers with respect to their knowledge. Then, they developed the pedagogical context knowledge framework as a result of their concerns about the knowledge, behaviour and language that teachers deploy in the social world of science teachers. Barnett and Hodson (2001) pointed out that teachers gained and expanded the knowledge through training and experience that enable them to apply it when they encounter different settings or situations in their classroom.

Barnett and Hodson (2001) were concerned with how teachers can empower themselves by critiquing, challenging, and ultimately changing their own knowledge base. They point to the value of collaboration between teachers and educators in research and professional practice, exemplified in Shulman's work, extended to the achievement of more effective curriculum development. This is achievable they argued when the teachers’ prime focus is taken to be the understanding and deployment of professional knowledge. Barnett and Hodson claimed the potency of the narrative process using the concepts of teachers' reflection-in-action and on-action, described by Schön (1983) as well as other key ideas from the mid-1980s: “personal practical knowledge” of Clandinin and Connelly (1987), the “practical knowledge” of Elbaz (1983), and the “personal knowledge” of Lampert
combined with the more content specific pedagogical content knowledge. They argued that a “teacher’s knowledge of a classroom is transient, subject to change, and situated in personal experience both inside and outside the classroom” (Barnett and Hodson, 2011, p. 431).

Sockett (1987) saw a basic flaw in Shulman’s (1987a) pragmatically grounded education reform programme directed, as Shulman said, at advancing the clinical status of teaching and teacher education. Sockett, like Barnett and Hodson saw the lack of specific attention to local context but also suggested the reform programme and research agenda appeared to be standards and assessment-driven. Sockett saw, in Shulman's (1987a) programme of reform an inadequate language to describe the moral framework of teaching and inadequate refinement associated between reason and teaching action. Sockett suggested that although Shulman was aware of teaching as a complex activity, he neglected the perception of teaching as a vocational occupation.

For Sockett, researching the knowledge base of teachers is not only a matter of understanding their pedagogical reasoning but also of understanding complex judgements of balance between the ideal and the possible practice rooted in the context and the local norms. This includes the social and perhaps the political that necessarily influence the daily practices and decision of teachers. Sockett (1987) indicated that Shulman’s analysis did not attend to the “moral craft” of teaching. Shulman replied that his epistemology of practice embodied the moral agency of teachers, the inverse of Sockett. Shulman (1987b) in reply indicated that he was concerned to describe good teaching across contexts and his work had been applied to better support and understand the development of a teacher. He wanted to help analyse within-subject designs and the thoughts and actions of the same individual from one domain specific teaching context to another. This he felt would have important practical applications to teacher education.

Hence, Shulman and Shulman (2004) have recently acknowledged the importance of analysing teachers’ work as a social practice through teachers’ reflections, at both the individual and community level by realising and highlighting that these levels are interdependent of, and interactive with, each other. They point to the value they have found in case studies of exemplary teacher's individual and collective pedagogical reasoning, in teacher education.
Similarly, Martin and Russell (2005), who argued that while attention to conceptual change is an important focus in teachers’ professional practice and teacher education, the teacher educator's activities should also have been supported by reference to the contexts in which the teacher is situated. They observed however, that the context of the practicum is rarely under the control of the teacher education programme. Often, they observed, there is discrepancy between the views of teachers and teacher educators, the structure of the programme and the experiences of teacher candidates. Martin and Russell (2005) highlight the need for teacher educators and researchers to listen and unpack teachers’ perceptions. Teachers’ reflections must be sought, taught, modelled and actively supported (Martin & Russell, 2005; Shulman & Shulman, 2004).

On the other hand, reviews of the research on the feature and progression of the subject knowledge of pre-service teachers indicate that most studies revealed that pre-service teachers showed little “integration or stability” in their subject domain knowledge (Cochran & Jones, 1998; Davis, Petish, & Smithey, 2006; Kennedy, 1990). In general, the researchers found pre-service teachers seemed not able to deliver their subject knowledge in an intelligible way and the teachers were unable to explain important science concepts often being taught in junior schools. This, it was argued because they themselves often did not understand these concepts. This was often claimed to indicate that having a major degree in a particular science specialty does not guarantee that a person can explain core concepts effectively. Parker and Heywood (2000) suggested that the limited time during teacher training programmes and courses prevents development of adequate understanding, or integration of the content knowledge with the pedagogy.

While secondary science students have been shown, in many studies, to have their own alternative conceptions prior to and even after instruction (Driver et al., 1994; Tsai & Chou, 2002; Wandersee, Mintzes, & Novak, 1994), teachers, and particularly student teachers, are also not free from the same misunderstandings. However, with teachers misunderstandings are fewer in number and the misconceptions decreased through the years of teaching (Bayraktar, 2009; Halim & Meerah, 2002; Wandersee et al., 1994).

In physics, for some topics, such as force and motion, are documented as difficult for students to understand as well as for their physics teachers. This, it is often argued, is due to the fact that these abstract formulations in disciplinary discourse are at odds with everyday meaning in conversational reality (Driver, Squires, Rushwort, & Robinson,
1994; Gunstone & Watts, 1985; Montanero, Suero, Perez, & Pardo, 2002; Savinainen et al., 2005). For instance, one of the common alternative ideas or misunderstandings is that force is an entity which belongs to an object (Brown, 1989; Haji Mohd Said, 2007). Driver et al. (1994) found that secondary physics teachers in training almost invariably hold to some naïve concepts in physics, particularly in the area of force and acceleration, concepts which have never been sufficiently challenged to bring about their rejection. Driver et al., in the same study suggested this revealed impoverished attention to the social discourse in classroom learning, both in the classroom and the staffroom. This study aims to explore, through teachers’ sayings and doings, of their physics knowledge and understandings in their discursive practice.

2.5 Review of Research on Teacher’s Identity

Identity-based research in science education has gradually shifted from investigating the psychological aspects of what motivate students or teachers to learning and how they acquire and accomplish their knowledge to adopting sociocultural modes of inquiry (Lee, 2012). Among the most favoured theoretical frameworks accepted among science educators in relation to identity was the figured worlds and practice theories. Lee explained by quoting Holland and her colleagues in 1998, how the figured worlds were taken as “historical subjectivities, consciousness and agency, persons and [collective agents formed and] forming in practice” (Holland, Lachicotte, Skinner, & Cain, 1998, pp. 41-42). Figured worlds can be shared with similar traditions of a particular society (Brickhouse, Eisenhart, & Tonso, 2006) as well as communities of practice (Wenger, 1998). Citing social theorists, Bourdieu, Bakhtin and Mead who take a middle stance between culturalist, as in totalised social, and social constructivist, Lee (2012) states that identity-in-practice typically coincides with practice theories. Lee elaborates that change in identity seems to take place as a result of discourses of past events and present situations that people act upon according to their settings.

Identity development for a teacher in becoming and being a teacher can be best characterised as a progressive and continuous process (Coldron & Smith, 1999; Connelly & Clandinin, 1999; Day, Kington, Stobart, & Sammons, 2006; Goodson & Cole, 1994; Volkmann & Anderson, 1998). Research that focussed on trying to understand teachers, their practices and their development has been emphasising issues that relate to their identity (Beauchamp & Thomas, 2011; Beijaard, 2011; Beijaard, Meijer, & Verloop,
Furthermore, “teachers’ beliefs and [their] practices cannot be examined out of context [as it] is complex and context dependent” (Mansour, 2009, p. 25). Teachers’ practices and identity are linked, as a person’s identity is shaped and negotiated, through everyday activities (Enyedy, Goldberg, & Welsh, 2006; Flores & Day, 2006). Everyday agential identity and personal meaning making in communities of science teaching practice has, however, rarely been the focus of critical realist research (Harvey, 2002). This is another point of divergence in this current research. The exploration of a teacher's identity or agency in a particular episode can provide a better understanding of how the individual develops relationships that exist within the culture and communities of practice (Wenger, 1998), that is their process ontology.

Eccles (2009) suggests that

“personal and collective identities develop over a lifetime based on (a) the social and psychological experiences individuals have as they are growing up and moving through adulthood; (b) their own agency in both interpreting and creating social roles and experiences that serve to reinforcement, redefine, or undermine particular personal and social identities; and (c) the co-construction of the content, meaning, and salience of various personal and social identities by the individuals themselves in conjunction with the people with whom they interact each day and over time” (p. 79).

Eccles (2009) suggests self-perceptions in two forms through which identity can be conceptualised. There are perceptions in relation to “skills, characteristics and competencies, and personal values and goals [which can] inform both individuals’ expectations for success and the importance of their involvement in a wide range of tasks” (Eccles, 2009, p. 78). Eccles also suggests three components of the motivational role of personal and collective identity namely value, content and efficacy. These components, in Eccles’ (2009) view, evolve through interaction with different experiences and meaning-making processes which eventually affect action. The value component looks at specific features of a person as an individual as well as a member in a group while the content component focuses on individual beliefs to his or her everyday actions and practices. The efficacy component, on the other hand, is what the person believes he or she could do, achieve and act upon on numerous actions.

Teacher development is inevitably idiosyncratic and must be viewed in relationship to the unfolding of a life history and in context (Goodson, 1991; Goodson & Walker, 1991). Teachers develop through life experience generally and of teaching experience...
specifically. Hence, in this study, the teachers’ perceptions, presented as narratives of self and others, are both cognitive instruments and cultural tools, in which are displayed social representations and cognitive polyphasia, which is the relational of the nature of social thinking (Jovchelovitch, 2012). Jovchelovitch (2012) explains cognitive polyphasia as a concept of human cognition which acts as a tool that not only enables adaption to context but also facilitates the expression of multiple identities which communicate between cognitive systems and knowledge to be adjusted, corrected and transformed (p. 444). Jovchelovitch further suggests that

“The concept opens the way to conceptualising cognitive systems as continuously developing systems. It captures how the dynamics of social interactions and cultural contexts is intertwined with processes of social knowledge and shifts the emphasis from equilibrium to process” (p. 444).

The concept of “from equilibrium to process” could be considered in this study. It is the knowledge of processing physics teaching in a given social encounter where physics teachers emerge and respond to the diverse sociocultural situations that characterise the teacher's experience. In this sense, each physics teacher's emergent identity is an asset in their cognition that enables “conversations” particularly with their students that adjust, correct and transform knowledge of physics teaching.

Beijaard (2011) emphasises that using the concept “identity” implies a holistic lens for looking at becoming and being a teacher. Research in teacher agency or identity formation can challenge assumptions about the education of teachers and teacher educators like myself. At the same time, these issues can increase our understanding on teacher development. Beijaard points out that such research stimulates awareness of:

“many aspects of the role as teacher educator in his or her working context (for example, influenced by the role of institutional norms and differences between male and female students teachers and pedagogy (for example, dealing with student teachers’ images or views of themselves as teachers, paying attention to identity issues in teacher education, and taking into account the complex interplay of influences on becoming a teacher)” (Beijaard, 2011, p. 516).

Flores and Day (2006) indicated that identity may be influenced personally and culturally which can be taken as an “ongoing and dynamic process which entails the making sense and (re)interpretation of one’s values and experiences” (p. 220). One example of this has been found by Sutherland, Howard and Markauskaite (2010) who examined pre-service teachers' self-image in transition from student to teacher. They found that the “teacher’s
voice” in a classroom environment were conceived of as emergent and developed through the ongoing process of students' interpretation of their experiences.

According to Schutz (1962), “[Previous] experiences in the form of ‘knowledge at hand' function as a scheme of reference” (p. 7) in order to comprehend certain characteristics of the perceived setting as objects in a material and personal grammar (Harré, 1997). Schutz argues individuals all carry knowledge of the world which originated from or attained as a result of personal experience that are gained mainly through social interactions. The teachers in the current research indicated that this was their interest for participating in what they saw as personal reflexive research.

Calderhead and Robson’s (1991) found that the concept of “mental image” appeared useful for student teachers, who may otherwise lack experience, in describing how their knowledge about teaching was held. Twelve student teachers, in their study, were found to generally have held “mental images” that influenced their interpretations of particular courses and classroom practices. These were based on past and present memories of their experiences and knowledge that they possessed during school years. They suggested these images influenced how they interpreted, planned and enacted their early teaching. The characterisation of these substantive memories as “mental images” is rather static, suggesting a cognitive inner eye and literal visual storage capacity. They could also be characterised as “social representations” employed and dramaturgically reinterpreted in narrative discursive processes (Harré, 2009; Jovchelovitch, 2012). A characterisation of the conversation between history and social psychology is important in this current research (Jovchelovitch, 2012).

Kelchtermans (2010) found that teachers build a very personal set of ideas and beliefs about what it means to establish and identify themselves as a teacher. In agreement with Jovchelovitch (1996), in this study, “semantic networks which organise [the] representational fields [of physics teaching] retain a degree of constancy in accordance with the historical features [of their symbolic field, physics curriculum, schools and] the societies from which they emerge” (p. 124). The complexity of these networks are varied with regards to the site-based practice and with how that practice is drawn upon to represent their identity in physics teaching in the social order. Furthermore, as explained by Jovchelovitch (1996), this study thus takes into consideration that in the social representations that teachers make of teaching, in order to perpetuate themselves as
physics teachers. As we live through an experience, there are things we encounter that will remain and those that may evolve. These, according to Jovchelovitch, became the main building blocks of social representation through which problems can be expected to emerge. In this sense, the teachers’ social representation of physics teaching in relation to my study “are inseparable from the particular stock of meanings and practices [that, in physics teaching,] will circumscribe the action and speech of [the teachers] as social actors” (Jovchelovitch, 1996, p. 124). However, the social representations, according to Jovchelovitch, are not only “inseparable from the dynamics of everyday life, [they are] also vary according to the positionings that different [teachers take in their own discursive contexts]” (Jovchelovitch, 1996, p. 124).

Enyedy and his colleagues (2006) found that teachers described themselves in their research in the changing institutional context of their identities, in relation to their classroom practices. This study, like the current investigation was influenced by Schatzki’s practice theory based in site-based ontologies. One of the two teachers in Enyedy et. al.’s study said she overcame her inadequate science content knowledge through experience and practice and, in particular, by developing the pedagogical content knowledge she needed to teach, using an inquiry and student-centred approach. Enyedy and his colleagues concluded that if science teachers were more reflexively aware of their identity formation in their practice, they would be more in control and able to change or adapt their current teaching practice. Eick and Reed (2002) also found that student teachers who reflected thoroughly on their past, be it their different kinds of teaching experience or experience when doing science, are seen to have a stable sense of self and identity in conducting structured inquiry teaching.

Beijaard, Meijer and Verloop (2004), in reviewing research studies on teacher professional identities, found that the concept of identity had different meanings consistent with researchers’ different approaches, purposes and contexts. They indicated most researchers characterised teachers’ professional identities as consisting of a set of sub-identities that are unique to each individual. These include a teacher’s initial work, existing knowledge and beliefs that enable teachers to behave and act based on his or her experiences. They found in their review that both concepts of “identity” and “self” are related and were often used to indicate the same thing. Despite the various meanings of the concept of identity used in the literature, the common idea is that identity is a relational
circumstance of interpretation and reinterpretation of experience of a person. As a result, they suggest that it is important for researchers to define and make explicit what is “professional identity” in the context of a study. Specifically in this study, through the teachers’ stories their identity formation could be understood within their practices. Each teacher’s social being and personal identity are formed in conversations at the interface of their private and public worlds (Harré, 1983).

Sfard and Prusak (2005) regards a collection of narratives and stories about people can be taken as identities. The narratives allow from a person’s activities for his or her agency to become visible through the dynamic nature of social life. They claimed that the focus of teachers’ narratives of identity formation is on the complex dialectic between identity building and other human activities. Storytelling was equated with the process of identity building. Teachers’ stories then should be taken seriously for what they appear to be, and their influence in shaping teachers’ actions needs to be recognised. They quote Connelly and Clandinin’s (1999) orientation to professional identity as “stories to live by”. They explain that teachers’ narratives of experience are personal, and reflect the history of life, in which the social aspects reflect their milieu. These are windows on the complex contexts in which teachers live and act.

Coldron and Smith (1999) claimed that professional identity is the way teachers give accounts to circumstances that they face with respects to others. The features of human agency that play an aspect to the formation of professional identity build upon teachers’ goals, and resources being available for them to reach those goals. Coldron and Smith argue, like Harré that social structure and teachers’ agency should be seen by researchers as an active process for teachers to see themselves, or being seen by others, in the process of their identity formation. Coldron and Smith observed that there has been more emphasis on the “personal” than to the contextual side of the identity formation. Thus, they suggested that more attention should be given to understanding professional identity formation with regards to the relationship between concepts such as “self” and “identity” and its context.

Walker (1991) sought teacher identities in a formal classroom, in a situation where the teacher is constantly “on stage”. This concept of “on stage” can be linked to Heidegger’s concept of a site or a “clearing” (Caldwell, 2012; Heidegger, 1982 [1927]; Schatzki, 2003, 2005). Schatzki (2005) referring to Heidegger points out that the
“clearing is an open place [that is] prior to all determinateness (things being such and such) and representation, in which anything that is, including human beings, shows up. (Imagine a lit-up expanse on the stage of a darkened theatre, in which people, actions, and entities appear)” (Schatzki, 2005, p. 469).

Specifically in the current study, the “clearing” can be taken as a space of intelligibility for the teachers where, in their doings and sayings, they make practical sense of what physics teaching is to them. This includes the ability to control the class, as well as involving appreciation of the norms of classroom organisation and their social identity.

While Goodson and Walker (1991) saw teaching as a biographical construct and a teacher's self as understandable through the examination of their life histories and their teaching strategies and actions in their classrooms, Lave and Wenger (1991) claimed professional identity formation is the socially grounded process by which a person becomes a participant in a community of practice. Wenger (1998) saw identity produced as a lived experience for teachers through their involvement and commitment in their own community of practice. The person’s self-knowledge in teaching-related situations, together with, and relationships to, professional activities, feelings of belongings and learning experiences result in a teachers’ professional identity. However, Linehan and McCarthy (2000) indicate Lave and Wenger’s approach had not sufficiently emphasise on the progress of identity change as a result of community of practice. Linehan and McCarthy suggest that recognising participants’ responses to social norms or “oughtness” in a specified community of practice could provide better understanding to the process of the emergent of one’s character or identity. That is the sense of what is right and should be done within the community. It is the response to what and how the teachers take as social norms of the representational knowledge as well as the embodied, responsive knowledge in which the physics teaching should be presented.

2.5.1 Science and Physics Teacher’s Identity

Thompson and her colleagues (2010) suggested the need to consider science teachers’ identities in and across different communities in order to support teachers’ development. In their study of eleven beginning secondary science teachers they focused on teachers’ language and story development about their own teaching practices. They took the notion of identity formation as a discursive, narrative act about what counts as professional practice across contexts. This purpose and approach is similar to that adopted in the
current study where the physics teachers’ conversational language of use could help to describe their agential identity and guide future teacher education.

Helms (1998) examined the connection between the subject matter of secondary science teaching and a teacher’s personal identity, which Helms referred to as a sense of self. He concluded that the self of secondary science teachers comes from what the teacher believes, values and wants to become, as a teacher, and not only from what the teacher actually does, or his or her affiliations. Their personal identity is “a sense of personal identification with [certain scientific knowledge, as well as with] their sense of what makes science teachers and individuals in the world” (Helms, 1998, p. 812). She argues that teachers can develop and enhance their identities as inquiry-based science teachers through experiencing scientific research, seeking broader content knowledge and undergoing rich in-service programmes (Helms, 1998; Volkmann & Anderson, 1998).

However, Solomon (1992) reflected that often science teachers and academic researchers have different interests in science education research. She observed that academic researchers often wanted to be able to understand teachers’ generic thinking or student learning particularly their cognitive psychology, whereas teachers seek to solve persistent, practical problems of explaining particular science ideas in contexts applicable to their classroom. There appear to be only a few studies that have specifically focused on science teachers and physics teachers in relation to their identity formation (Luehmann, 2007; Melville & Bartley, 2013; Thompson et al., 2010). Writers such as Holton (1978/1998aa) and Mackay (1971) focused with different emphases on physics teachers’ and students’ possible, intended and actual knowledge of physics, with little consideration of a teacher's site-based ontology, implied moral context and social orders.

### 2.6 Literature on the Discursive Investigation of the Site-Based Ontologies, Moral Contexts and Social Orders of Physics Teaching

The research reviewed above overwhelmingly supports the common assumption that physics teachers' accounts of physics teaching are formed by and inform their practice. Rather than seeking knowledge hidden in the brain of the individual, knowledge is sought in discursive practice, personal positioning in teachers’ doings and sayings about physics teaching at different stages in their career, about their practices with respect to their institutions and societal rhetoric. The concept of personal positioning theoretically
elaborated by Davies and Harré (1990) and Harré and van Langenhøve (1999) in the debate regarding discursive psychology, embodied in assumptions of intentionality and the causal or instrumental function of everyday conversation. According to Harré and van Langenhøve (1999), the narrative self emerges from two basic principles of social constructionism as:

“i. What people do, publicly and privately, is intentional, that is, directed to something beyond itself, and normatively constrained....

ii. What people are, to themselves and to others, is a product of a lifetime of interpersonal interactions superimposed over a very general ethological endowment” (Harré & van Langenhøve 1999, p. 2).

These principles emphasise that, in and through conversation and conversation-like activities that social phenomena are created.

Positioning theory offers “a dynamic, agentive model of identity construction where a person creates a possible identity for themselves, in a particular context through their active positioning in relation to, or perhaps in opposition to, elements in their discursive cultural context” (Linehan & McCarthy, 2000, p. 449). The social and psychological realities are actively produced as a result of “a structured set of speech-acts” (Davies & Harré, 1990, p. 45). The “sayings and doings…by reference to [the] social (illocutionary) force…and positioning…are socially determinate” (Davies & Harré, 1990, p. 45). Tensions that might occur between a teacher's purposes and the local moral order in their school can be recognised in their sayings and doings. For example, at the intersection between a teacher's purpose to enact socially and culturally rich, constructivist physics teaching, grounded in the social and cultural experiences of his or her students, and the necessity to prepare these students to use mathematical algorithms to answer standard questions in various forms on university entrance examination papers, they have to interpretively construct a professional identity that is intelligible within the norms of their school, and a discursive circle of significant others subject to the changing physics curriculum and local space/time requirements of the timetable.

Shotter (1993) points to the differences between disciplinary discourses and conversational realities illuminated in the work of Harré, Vygotsky, Bakhtin, Vico and Wittgenstein. He suggests disciplinary discourses are based on teachers’ everyday conversations with others in their practices. The discourses are sustained in spontaneous
and responsive relations to each other in conversations concerned essentially with representational meanings. He also suggests conversational realities have their origins in the practical moral knowledge which the teachers only realise of having it through their practice; knowledge which Shotter calls “knowing from within” which exists alongside “knowing about” and “knowing how”. “Knowing from within” as indicated by Shotter (1993) is “the social situation within which it is known, [by] which people are able to influence each other in their being rather than just in their intellects [or reasons]” (Shotter, 1993, p. 463).

Rawls (2011) points out “changing our conception of how language works as a cooperative constitutive process changes the understanding of what information is” (p. 412). She argues information is often taken as a social object such as an information system like physics teaching or scientific fact in physics theory. This notion of information, she posits, serves an institutional order. Rawls suggests that it is essential for this information to be related to constitutive social practice, and hence to its constitutive order. Rawls like Harré is suggesting that making sense in the language, meaning and order of shared social objects such the epistemological objects of physics teaching entails “a constitutive order of ‘use’ practices that exists as a social institution of some sort” (Rawls, 2011, p. 402). This, Rawls indicates, demand continuous observation, teamwork and collaboration as well as moral integrity. Rawls elaborates the need to understand that

“meaning is a constitutive social process (that meanings are made as we interact and can change with each next move) and then not formulating that process in a sufficiently social, reflexive and constitutive way (relying on the static notion of social institutions, words, Speech Acts, or other units of meaning) has been a problem” (p. 402).

The notion of “technologies of the self” described by Foucault (1988) as discussed by Burkitt (2002) refers to the knots of reason that a person applies to transform themselves and their agential or functional identity in social practice. Foucault identifies four types of self-functional reasoning: production, signing, power and self. Each is defined in the next chapter. Both Harré's positioning theory and Foucault's technologies of the self will be used in the semiotic analysis of the physics teachers' accounts of their practice.

Shulman and Shulman (2004) suggest that in the dynamic moments of teachers’ practice, and reflection on it, teachers construct and reconstruct their identity throughout their teaching career, in the dynamic moments of their practice. Each teacher places different
priorities on what they consider makes effective teaching, which seems to depend upon how each teacher reflects on their practice and their purposes.

Gunstone and White (1998) in their studies with senior high school physics teachers found that what influences teachers’ attitudes to classroom practices was often intertwined between the goals of education and teachers’ personal perspectives of teaching and learning, as well as their views on the nature of science. Beauchamp and Thomas (2009) point to the need to consider the “reflective attitudes” teachers bring to the research conversation. Hence, Dewey’s descriptors of four kinds of reflective attitudes; whole-heartedness, directness, open-mindedness and readiness (Dewey, 1933; Rodgers, 2002) have been used in this current study. These reflective attitudes are used to describe the affective engagement of the interviewees in discussion of four common place aspects of personal professional development: vision, motivation, understanding and practice that organise the presentation of each the teachers' accounts and analyses (Shulman & Shulman, 2004).

Research in physics teaching has often assumed an international context, thereby neglecting the personal context and the local moral order or context. As discussed above, research in identity formation has suggested teachers' cultural identities influence and inform teaching practices. Providing opportunities and supporting teachers to discuss their perceptions of their social agency in their sociocultural milieu were thought to be important in seeking a better account of their identity formation. The current study has aimed to explore, through teachers’ stories and experiences, how teachers’ identities have been shaped by, and shape, their everyday discursive practice as physics teachers in schools. The methodology of this social phenomenological narrative research will be discussed in detail in the methodology chapter 3.

While I decided to use the concept of identity to introduce teachers' social agency, the literature on teachers’ beliefs informed the construction of my interview questions, and the analysis of responses. In this study, one of the assumptions taken into account is that teachers’ agency is formed not only by reference to global principles and their practices rationalised retrospectively against these principles but also through local cultural projects that teachers may commit themselves to prospectively. In this research approach the teacher's practice is process ontology with “conversational” properties. This conversation is taken as the basic social entity by which personal identity and
organisational practices are reciprocally transformed in the local moral order of the school community and wider social orders. Leonard (1983) suggests for a better understanding of lived experiences with phenomenology is to include researchers themselves as their life are certainly have been influenced by their consciousness and awareness towards intentions and feelings. In this study, it is assumed and accepted that teachers come with certain predispositions and identity that are important to them and that these include their identity as a physics teacher.

2.7 Summary

Regularly, researchers claim that unpacking teachers’ knowledge and beliefs through teachers’ voices and stories, as social representations can reveal better meaning and understanding of teacher development (Aoki, 2008; Butt, Raymond, McCue, & Yamagishi, 1992; Clandinin & Connelly, 1996; Connelly & Clandinin, 1990; Jalongo, Isenberg, & Gerbracht, 1995; Sutherland et al., 2010). Allowing teachers to discuss and simultaneously reflect on how their personal perceptions, values and beliefs, as is often claimed in the research reviewed, could inform their professional identity formation. Action-theoretical discussion of how and when or why teachers use certain knowledge in their practice is seen as the essential context (Beauchamp & Thomas, 2009; Calderhead & Robson, 1991; Desforges, 1995; Enyedy et al., 2006).

Essentially, the study of teachers’ perceptions in relation to their identity, which include knowledge and beliefs, are seen to more likely inform researchers about aspects of a teacher's subject knowledge and their interaction and relationships with others in the same field. However, this research often substantivalises processes, such as knowing and believing, as products or objects and brings us no closer to understanding the social process. Research in the field of learning to teach and the improvement of teaching, has produced interesting descriptions and hypothetical inter-relations between teachers’ knowledge, skills, beliefs and practice. However, experience is personally indeterminate, just as theory is indeterminate in a particular context.

Accordingly, many studies have reported relationships between what informed teachers practices and how they discussed about them (Clandinin & Connelly, 1996; Jalongo et al., 1995; Kelchtermans, 2010; Northcote, 2009; Tobin & Espinet, 1989; Tobin, Espinet, Byrd, & Adams, 1988). Kelchtermans (2010) indicates that teachers’ stories can be
analysed to reveal their subjective perspective on how they are positioned and position themselves within the context of their social and cultural environment, in and around the school. Teachers’ stories usually are bound up in the illumination of their lived experiences and consist of events that are held to have a significant meaning to the teachers. Teachers’ stories are usually believed to reveal the deeply held ideas the teachers have about themselves as a teacher, their values and dispositions, as in this study, toward good physics teaching which teachers find in their disciplinary knowledge. Teachers’ stories are only link and connect past experiences with present concerns, but also with future goals. However, teachers’ stories which tell and retell lived experiences are often presented as internalised monologues rather than as dialogues. The “rules” of practice and agency are seen to be forming in everyday conversation at the intersection of teachers’ intentions and necessities, in which teachers’ personal journeys are seen as being shaped by context and choices, perspective and values.

Furthermore, it is often far from clear how the meaning in these monologues has been made determinate by researchers. Such research has frequently collapsed habits of “interpretation” and “belief” into “belief”. As Heiskala (2011) argues the tension between these should be maintained in social phenomenological research. Only occasionally has the reviewed research reported disconnections and inconsistencies between the habits of interpretation and the habits of belief, or the habits of action and either of the former (Brown & Melear, 2006; Eberle, 2008; Kang & Wallace, 2005).

Researchers call for more teachers to reflect on their teaching and teacher education programmes in order to guide and support teachers to voice out their views and beliefs (Richardson, 1996; Rodgers, 2002; Shulman & Shulman, 2004). It is often argued that a more clear explanation on the relationships between teachers’ beliefs and their everyday practices could be achieved when teachers are made aware of their own implicit belief. However, the process by which this would occur remains unclear. Hence, the challenge in conducting this study is to hold both the person and their context in focus and consider the dialectical relationships constructed between the physics teacher and the intelligibility of physics around their practices and the mediating pedagogical objects in a particular time and space. The physics teachers’ discursive practice concerned essentially with the explanation of the secret lives of physical things in physics is expressed as a social act via the operation of everyday practices. Informed by Wittgenstein and Vygotsky, the current
study takes everyday “conversation” as the metaphor for the basic social reality. That is, everyday “conversation” which involves self and other positioning in doings and sayings at the intersection of private and public psychological spaces, is causal both in identity formation and organisational change. This study researches each teacher's positioning in their own stories and their illocutionary force in exploring the social orders that shape their agency embedded in their practice and its institutional organisation.

The participants’ reasoning about their teaching and the emergent intelligibility of physics teaching involves their response to their local moral order, as much as to their practical epistemology. The context a teacher embraces includes features such as places, feelings, personality, plans, action, time, knowledge, syllabi, examinations, student expectations, and experiences which varies according to these types of situations. This is what this study will explain through the teachers’ stories and reasoning. The teachers’ agency, accounted in habits of action, interpretation and belief, is emergent in their social practices, not just in explicating the world of physics. In this study, the teachers’ stories and their reflection will be shown to be varied, according to local norms, their perceptions of their contexts, “roles” and biographies.
Chapter 3  Methodology

“People are positioned or position themselves with respect to rights and duties to act within evolving storylines, and on the basis of claims about relevant personal attributes, the discursive process of prepositioning” (Harré, Moghaddam, Cairnie, Rothbart, & Sabat, 2009, p. 5).

3.1 Introduction

This study attempts to provide a better description of how secondary school physics teachers' practical understanding of teaching develops, is constructed and reconstructed in their schools. This was done by analysing their discursive positioning and repositioning in their own conversational accounts in a series of research interviews. The study assumes teaching is a social practice and explores the local moral order within which physics teaching is practised in secondary schools by attending to the personal and material grammars employed by the teachers in structuring their accounts of their practice. This social phenomenological study seeks to provide case studies of teachers' identity formation, continuously holding both the person and their context in focus in the analysis of everyday meanings in the research conversations at the analytical level of both the individual and institution. It is hoped the study will be seen as a contribution to the literature on physics teaching and also to the improvement of professional practice, both in schools and teacher education.

The literature recommends that one of the ways to gain better insight into physics teaching as a social act is to explore the link between teachers’ practice and their personal identities through stories and narrative. Within a lifespan, while personal identity is generally considered at some level to be stable, social identity generally changes. Teachers’ stories have been held to provide access to events and deeds in their biographies that have a symbolic meaning to them, dramatising deeply held ideas about themselves as a teacher, as well as disclosing their values and dispositions towards what good teaching is. In their stories, teachers position themselves in their moral careers (Bullough, 2008a; Butt et al., 1992; Clandinin & Connelly, 1996; Goffman, 1981; Goodson, 1992). Goodson (1992) claims in order to understand teachers’ positioning and selfhood in their accounts of dynamic social episodes in which their practice engages them as both teachers and physics teachers, it is critical to listen and speak with the teachers in order to get to know about them and to recognise the impact they bring about in their practices.
Positioning, as it is used in this study, is “the discursive process whereby [the teachers] locate [themselves] in conversations as observably and subjectively coherent participants in jointly produced storylines” (Davies and Harré, 1999). A teacher's account of a social episode can describe how the teacher interactively positions others or is positioned by them in everyday discursive practice or reflexively positions him or her self. In either case, this positioning may be conscious or unconscious. In this study, the teacher is taken to live their life with regards to how they carry themselves regardless as to who or what might be accountable for the kind of individual he or she has become.

A descriptive approach on the teachers’ social representations allows for initiating Vygotsky’s cultural, historical and/or instrumental psychology which as indicated by Harré, a process that enable for better description of how the culture of physics teaching is reproduced. Harré (2009) has insists “for Vygotskian collective-based psychology, which [regards] individual psychology [as] a product of intimate social processes” (Harré, 2009, p. 473). The Vygotsky’s theory allows an apprentice when doing activities in the Zone of Proximal Development (ZPD) to gain skills that prompt progression from one level to another. The apprentice, according to Harré (2009) obtains “the ‘rules of the game’ of [both] what to do and how and with whom in a ‘conversational’ process, in a social setting with people showing or telling what to do, supplementing the learner's attempts” (Harré, 2009, p. 470). The apprentice in this study is the teachers. The “game” of physics teaching is often played in isolation in a typical secondary school, separated from other practitioners who work in other schools but the “rules” seem to be well known and the social order of practice is stable. Thus, the social representations of physics teachers need to be studied in this light of this physical isolation.

Furthermore, Harré (2009) points out that when reporting people’s social action with the concept of “rule”, great attention is required to focus on the people. In this study, “rule” is used for presenting a teacher's norm. Thus, it seems essential to provide the teachers’ accounts of their emergent committed grammars, personal predispositions and knowledge as physics teachers. The teachers’ accounts can give everyday narrative insights into the processes that involve in physics teaching by considering cultural aspects as to how teachers see themselves in their world of practice.

This study explores the discursive practice of each teacher's agency in their accounts of their positioning and repositioning in institutional practices and societal rhetoric.
According to Jovchelovitch (1996) “inquiries about everyday practices and knowledges [of physics teachers] are not restricted to social psychology [and] transcend disciplinary boundaries with the other human and social sciences” (Jovchelovitch, 1996, p. 121). Teachers’ everyday practices and knowledge includes not only their experiences and their networking with communities of physics teachers but also their professional identities. Therefore, Jovchelovitch (1996) describes “knowledges” as

“forms of knowing that circulate in society, which are part of erudite, scientific and popular culture, which mingle, feedback into each other, and emerge as social resources for a community to make sense of its reality and to know what is going on” (p. 126).

In the teachers’ accounts, it is taken to be enacting or dramatising the ethogenic processes of their actions in the everyday practice as a physics teacher. Garfinkel (1967) calls this “accountings” in socially dynamic situations which he described in *Studies in Ethnomethodology* as their norm referenced transactions.

“... the activities whereby members produce and manage settings of organized everyday affairs are identical with members’ procedures for making those settings 'accountable'... [by which] I mean observable - and- reportable, i.e. available to members as situated practices of looking and telling” (Garfinkel, 1967, p. 1).

However, definition of “accounting” by Garfinkel is similar to what Schutz refers to “reflective intentional act”. There is the need in social phenomenological studies to supplement analyses of reflective intentional acts with the analysis of meanings that are not explicated by the teacher. It can be by using research approaches such as “the practice turn” (Schatzki, Knorr Cetina, & Savigny, 2001) and discursive psychology (Harré & van Langenhøve, 1999) that both argue that intent may be unconscious or habitual. Both approaches draw on Wittgenstein's (1958) preoccupation with the details of ordinary linguistic usage in specific contexts and his idea that meaning is best explicated through examining the use to which certain expressions are put in “conversational” settings. In the current study, Schatzki's approach to the study of practical intelligibility and Harré's positioning theory are employed to analyse the process ontologies of the physics teachers.

In their narratives, the teachers discussed practical and expressive issues and challenges in transacting profound knowledge of the physical world, in the mandated senior physics course with their students. This study is impelled by my own experiences of the significance of the socially grounded perceptions and experiences of beginning teachers in shaping their personal style commitments. Students in school discursively position
their teachers; similarly teachers are positioned in the local moral order of school or ZPD of the physics domain. Teachers are engaged in transacting social representations of their rights, duties and responsibilities in explaining particular scientific knowledge to their students (Jovchelovitch, 1996). Just as students take on labels schools give them, both academic and social, teachers take on social representations that work in discussions with their students; concepts that they find policy directives or shared knowledge that are given to them.

The review of the literature on science and physics teaching in chapter 2 has increasingly emphasised the significance of the teacher’s personal vision or ideology, commitment, knowledge and practice. There is a shifting from a phenomenological frame of reference for understanding teaching towards an action theoretical frame of intentionality or goal directed action. The studies offer a convincing critique of the structural-functional view of science or physics teaching as an objective reality which do not always takes account an individual’s perspective. Yet, they often point to the significance of time-place considerations in their accounts of teacher agency and the further need to explore teachers’ perceptions and social ontological processes in which they are embedded in order to better describe teachers’ multiple professional identities including how and when and why teachers do what they do in their practice (Anspal, Eisenschmidt, & Löfström, 2011; Beauchamp & Thomas, 2009; Calderhead & Robson, 1991; Desforges, 1995; Enyedy et al., 2006). Beauchamp and Thomas (2009) in concluding their review of the literature on teacher identity suggested that

“a teacher education programme [either pre-service or in-service, in schools or university] seems to be the ideal starting point for instilling not only an awareness of the need to develop an identity, but also a strong sense of the ongoing shifts that will occur in that identity” (p. 186).

The literature reviewed in chapter 2 suggests that to be a good teacher or to regard an other as a good teacher requires more than having adequate subject knowledge or being able to understand concepts and their interactions in a particular epistemological domain. It is also the practical intelligence that demonstrates they can comply with the norms and expectations of others in their various practice communities (Coldron & Smith, 1999; Davis et al., 2006; Eccles, 2009; Kelchtermans, 2009; Mansour, 2009; Shulman & Shulman, 2004). Every “rule” of good teaching or proper conduct that the teacher constructs for themselves is based upon assumed norms through which the individual teacher embodies certain values in their teaching practice. The norms of the teaching, as
defined in chapter 1 are taken as a teacher’s constructed space of reasons in a shared form of life, which requires that tasks to be carried out together (Brinkmann, 2006). The professional lives and actions that teachers enact are inextricably embedded in a culture which has resulted from the dialectical interaction between individuals and the everyday sociocultural lived milieu. Thus, teachers’ actions are embedded in their practices (Tobin & McRobbie, 1996). These researchers go further than previously in denying the existence of a determinate set of common beliefs and values underlying social cohesion generally and science or physics teaching specifically. They do not assume that there is a fixed and unanimously agreed social reality. Indeed they stress that the world of the teacher is made of “multiple realities”, even for each individual. Nevertheless these researchers do tend to accept at face value the meanings of the social transactions the teachers describe while not necessarily accepting the “official” account of them.

In phenomenological research, meanings are knowledge and in this current social phenomenological study teachers’ meanings are their everyday knowledge. I contend that cross-situational meanings should be explored. How a situation appears to one participant or set of participants at a certain stage in their career cannot be equated with the meaning it has for others in apparently similar situations. Therefore, this study attempts to get behind the obvious consciously accepted meanings of social situations to the understandings which are presupposed in the explicitly formulated practices of social participation in physics teaching. This involves a detailed study of reasoned and sub-conscious assumptions of the everyday practices of physics teachers. This study sought to find out what makes physics teaching practically meaningful or intelligible to the physics teachers interviewed and observed in their schools. In the research interviews, the teachers discussed the doings and sayings of their physics teaching, including their expectations and experience of formal and informal teacher education programmes. This helps to locate them as actors in their own discursive identity formation.

The key organising research questions were:

- What personal and social meanings do the participating teachers attribute to their practice as a physics teacher?
- How do the teachers position and reposition themselves in their accounts of their practice, in relation to the norms of senior physics teaching and, more generally, teaching in their schools and beyond?
How do these teachers describe the processes which have contributed to their professional identity formation as physics teachers?

3.1.1 Perspective Taking

Language use, joint action and the ethical domain are clearly important in understanding the relations between the embodied person and their surroundings as well as the emergent form of life of physics teaching with its own distinctive characteristics. Both researcher and teacher, “are ‘present’ to each other as who [we] are, [that] we can ‘see into’ each others ‘inner lives’” (Shotter, 2011b, p.1). As the researcher and the teachers are clearly from different cultures, agreeing with Shotter (2011b), we are strangers “with whom we have become involved [for the purpose of this research that] we [may] quickly look away again, lest we reveal too much of ourselves unnecessarily” (Shotter, 2011b, p. 1). Place and time are real or causal in this perspective taking. Shotter (2011b) argues that,

“in our living contacts with an other or otherness, [student or colleague], our mere surroundings are transformed into ‘a world’, or at least, into a partially shared world that we sense ourselves as being in along with others and otherness around us. And besides having an ethics and politics to it - besides our having expectations within it as to how the others around us should treat us and are likely to treat us - our partially shared world has, we feel, a unique culture to it” (p. 1).

Shotter (2011b) further explains that the shared world is occupied with entities that are related to each other that not only have certain values for us but also that matter to us. Shotter identifies this in terms of how we consider and understand identity which in this study is as a physics teacher or teacher educator. In agreement with Shotter (2011b), this study accepts that,

“Overall, [each of the teachers] is simply a person with a ‘life of their own’ among other [teachers] with ‘lives of their own’, with us all expecting in [their] meetings with each other [and with the researcher] to be treated as such” (p. 1).

In this study the perspective taking is seen as dialogically constructed and presented, a conversational journey. Gadamer (1989) contends that our interpretations of ourselves and others can at best be seen as movement towards a fused horizon between the actors, who cannot be “known” in the full sense, and the researcher, which requires a mutual embracing of biases or ideological differences about what it is to be a physics teacher. This requires appreciation of conscious and unconscious influences of my own social and moral culture on my own habit of interpretation and habit of belief on the conduct of the research and my interpretation of the meanings in the teachers’ accounts.
Mead’s social psychology is important to this understanding of dialogical perspective taking focused on the self, community, emergence, and “me” and “I” in everyday discursive practice. Re-reading Mead’s social psychology, Martin (2005) explained that “it is consciousness of meaning that permits an individual to respond to her own symbolic gestures as others who understand them are likely to respond” (p. 234-235). Further, Martin (2005) elaborated that Mead’s organisation of perspectives is based on social conduct in a cooperative process that through reflection on the relationships between individuals and their practice world enable him or her to consider the perspectives of others. This, Martin further explained is done by taking the perspectives of others not only by having awareness of what they want to achieve but also ability to take in difficult and complex circumstances that they have to face and also ability to interpret and act on resolving a situation which involve individuals and everyone.

In the same way, Schatzki (2000) goes further suggesting human existence in social life directs “how people’s hang together through the intelligibility that governs what they do, the actions they perform, and the layouts of, as well as connections among, the material settings in which they proceed” (Schatzki, 2000, p. 21). Schatzki (2000) argues that practices in social life, such as those which are educational or political correspond to

“common locutions are open-ended sets of action, each linked by pools of understandings (pertaining to action), sets of rules (explicit formulations), and ‘teleoaffective structures’ (spectrums of normativized, hierarchically ordered ends, projects, and tasks, to varying degrees allied with normativized emotions and even moods)” (p. 24).

In my perspective taking, I attend to both the teacher's meaning making and my own in interpreting dialogic and dialectic aspects of their personal positioning in the storylines they present of their teaching. The teacher exists in the present, in the interview context. Their perceived self and my perceived self are something that I take or experience introspectively and share in the research conversation. What I am analysing is physics teaching as a process ontology, not a finished social representation. The cultural or discursive, agential or actual, and the structural or the possible are elemental levels to be integrated into my social ontological enquires. In the dialogical accounts, I was concerned to provide fine grained description of how the teachers made choices and how a decision is made out of the choices that they have in order to meet the norms in their practice community as well as their schools’ expectations of them. The teachers’ accounts will describe the social meaning and the making of social meaning in physics teaching.
3.1.2 Teachers’ Lives, Narrative and Stories

Teachers’ stories and lives have been explored for what they could reveal of themselves and their agency within the moral context of their social and cultural practice in and around their school (Bullough & Baughman, 1996; Davies & Harré, 1990; Kelchtermans, 2010; Wood, 1992). Bruner (1986, 1990, 2004) has argued that human thought is organised and patterned by storytelling: the organisation of experience in terms of plot shapes the very structure of our thinking and our sense of reality. From the late eighties onwards, many academics like Bruner and Harré have pioneered psychological research that reconsiders knowledge and truth as informed by narrative or conversational principles. This is the point of departure in this current research. Teachers’ conversational narratives are studied for what they both describe and explicate of the socially constructed nature of reality and knowledge, because they can identify the disjunctions between their story-telling teachers and teaching as a life.

Polkinghorne (1995) indicated how stories allow a person to express and describe actions and happenings based on his knowledge and experiences. Accordingly, teachers’ stories are often taken to be real or causal in the sense that they are held to shape, as well as being shaped by, aspects of teachers’ subject knowledge and their interaction and relationships with students, colleagues and their community of practice (Mansour, 2009; Sutherland et al., 2010; Wenger, 1998).

Colyar and Holley (2010) suggest that narrative has the attraction of fixing the actors’ meaning to their actions thus ensuring a certainty of interpretation. As narratives tend to reveal a story or set of stories with the reference of the time of the events, it allows the researcher to see the connections of the stories and the ways in which a story is told. In this study the location of the teachers in time and space in their own storyline is important. The narratives in the current social studies represent teacher’s everyday meaning or knowledge in the data analysis and transcription (Bullough, 2008b; Bullough & Baughman, 1996; Colyar & Holley, 2010; Van Manen, 1990). Butt and his colleagues (1992) point out that by comparing and contrasting small collections of site-based teacher stories, the narratives can represent both commonality and uniqueness across social contexts to teachers’ professional lives, individually and collectively. In this study, how the identities of the physics teachers have been shaped by their lives and their doings and sayings in their schools are explored through their stories. Fawns and Sadler (2000) argue
teacher narrative research can describe highly individualised or culturally stereotyped stories by providing opportunities for teachers to display a moral identity or individuality through the selection, organisation and presentation of personal experience and meaning.

Van Manen (1990) argues that through analysis of teachers' narrative reasoning their stories can give accounts of the way they have developed over time into the kind of persons they are now. Similarly, Bullough and Baughman (1996) argue for the power of narrative reasoning, as a mode of inquiry that can provide both a powerful influence and lessons in the development of both teachers and researchers. They indicate how, in narrative reasoning, one is able to answer to oneself and others for what we are and are becoming. They point out how stories may be treated as data and comparisons made by those whose stories are told or by those who listen or read them for what can be learned about teaching and teacher development. However, they also indicate without doubt, the stories of self are partial and cannot possibly be told as a whole story for a teller who must select what to say, as well as when and how to say it, and not say something in the various contexts including that of the research interview. Bullough (2008b) discusses the point that each teacher makes teacher education meaningful in his or her own way and the everyday social act of composing narratives and stories helps teachers to recognise and respond to the complexity of teaching and make a better sense of the experience and practice of teaching and teacher education.

Clandinin and Connelly (1996) classified three types of teachers’ stories into i) broad cover, ii) sacred and iii) secret functions that give referenced of their social being in particular narratives in this study. Cover stories can be taken as the public kind of stories that are freely shared with others who are not necessarily from the school setting. Cover stories are usually what the school and teachers want outsiders, including parents, to know about which teachers portray themselves as experts in presenting acceptable accounts of the doings and sayings in the school. Sacred stories are indeterminate stories of doings and sayings but are still considered as “public”. They are usually the practice stories of the school and of the teachers, stories of a school, school policies or curriculum documents. These stories are usually the ones that influence teachers’ day-to-day practices and may be seen as informing and informed by norms of practice. Secret stories are often only shared at secret places with the closest friends or partners. The secret stories are stories about teachers’ own personal classroom interactions with students, as well as the
truths and the realities of daily discursive practices that are not often talked about. In this study, recognising the types of stories that the teachers shared had allowed the grouping of commonality and differences among the teachers stories.

3.2 Research for Examining

“While physics and chemistry make use of numerical measures and characteristically theorize by proposing unobservable causal processes, descriptions and explanations in the human sciences must pay regard to other standards of precision...and make use of other explanatory modes than the reference to theoretical entities” (Harré & van Langenhøve, 1999, p. 3).

Hence, following the concept of positioning, the discursive phenomena of the teachers in this study take into account that teachers’ teaching skills are based on their capacities to use language to produce representations of physical phenomena as well as their abilities to take in the requirements or guidelines in schools which influence their social life (Harré & van Langenhøve, 1999). van Langenhøve and Harré (1999) suggest the different kinds of positioning, such as first and second order, performative and accountable, moral and personal, self and other, tacit and intentional (p. 20). These modes are derived from interpersonal discursive processes perhaps in the manner described by Vygotsky (1978) which focus on how forms of practice like teaching involve the use of symbolic systems.

Harré (1983) proposes a more psychologically developed model of the process of transformation of social being, personal identity or agency as well as reciprocal organisational transformation, in and through everyday discursive practice. Research in the area of identity and identity formation has typically proceeded without such a reciprocal model. In Harré’s model, as applied in the current research the transformation of teacher’s social being, personal identity or agency, occurs in and through their everyday discursive practice, occurs in a 2 dimensional social-psychological space of teaching: public-private and social/collective-individual as schematically represented in Figure 3.1. Teachers’ everyday discourses shape not only identity transformation but also simultaneously institutional reorganisation.

Harré (1983) argues that the social being and personal identity are formed in conversations at the interface between public and private world in four quadrants (Q1 to Q4) identified as four ontological processes of identity formation and organisational transformation as shown in Figure 3.1. The model does not assume that this identity
formation is always linear, it may be recursive at any point but the general movement is as shown through Q1 to Q4. The teacher’s personal identity or agency can be said to develop from conventionalised doings and sayings embedded in institutional practices in their practice-narrative circles Q1. They first selectively appropriate Q2 and then reconstruct or internalise “rules” of conduct Q3 each at the intersection of their purposes and social necessities in the school. Their performance practice comes to represent as social meanings that if conventionalised in the doings and sayings of their practice-narrative circles in the school Q4 will transform the institution. For Harré’s discursive psychology here as with Shotter (2011b) and Watson (2006), identity is necessarily relational and has meaning when it is recognised and considered within a chain of relationships and can be used to describe how “teachers actively construct their identities as professionals in an ongoing, effortful and dynamic process [in their everyday practice]” (p. 512).
In any educational episode between a teacher and student, the social dynamics of that one single episode could be appreciated through roles and general rules which the teacher and the students occupy, as well as their previous conversations that are the history of their interactions (Harré & van Langenhove, 1999). Hence, both the past and insight of the current conversation are necessary. Harré and van Langenhove (1999) further suggest that as something stays indeterminate in any episode, prediction to what will happen next in a teaching and learning episode is made impossible. However, that does not mean that the teacher or researcher is not able to understand episodes and interactions in detail.

Harré and van Langenhove (1999) argue that how the social and psychological phenomena are “constructed” could be understood and be explained in terms of what is going on by looking at three basic features of conversational interactions. They listed these three basic features as follows:

- “the moral position of the participants and the rights and duties they have to say certain things,
- the conversational history and the sequence of things already being said,
- the actual sayings with their power to shape certain aspects of the social world” (p. 6).
In this study of the practices of physics teachers, both conceptual and methodological approaches are considered which merges sociological, psychological and social-psychological perspectives (Harré, 1993). These three perspectives, with respect to this study, are described as follows:

- The sociological perspective involves at least two social orders. One is the organisation of work. This is called the practical order. The second order concerns the organisation of honour and Harré calls this the expressive order. The teachers in their conversation dramatise a social life in society and hence their own community of practice within both the practical and expressive orders that usually depend on the historically available resources or conditions of teaching. For example, the socialisation of the physics curriculum as a resource to be “followed” by the physics teacher.

- The psychological perspective considers prior structures are realised in the intentions of the teachers and presented in the discursive practices of the physics teachers. The discursive practices of the physics teachers in this study encompass their positioning acts in their accounts of their everyday practice, institutional practices and societal rhetoric.

The socio-psychological perspective in this study considers many features of the “mental life” of physics teachers; their personae can be seen to be derived from social forms and conversational circles. These will include the disciplinary discourse and the conversational realities of staffroom and classroom communications, but may also include broader duties and responsibilities in their school and beyond.

Both the sociological and psychological perspectives need to be considered to bring together consideration in the mutuality of agency and structure of what and why teachers do what they do. The socio-psychological perspective serves a better elaboration of the indeterminacy, tensions and dilemmas that emerge in specific activities in their community of practice (Lave & Wenger, 1991; Linehan & McCarthy, 2000; Traianou, 2006; Wenger, 1998). The active constructive process, by which physics teaching becomes intelligible, involves an understanding of the nature of that special sphere of activity through joint action and dialogue (Shotter, 2011b). Shotter describes that in using his notion of “conjoint spontaneous involvement and the associated relational opportunities” (Shotter, 2011b, p. 4), are not only afford us to see ourselves as free agents but also our rights and duties as intra-actants with involvement obligations. Shotter further
discusses the importance of a focus on teachers’ voices as their utterances brings about their being and existence to their own setting and environment. An individual’s understanding of concepts, theories and ideas of a particular practice community or “form of life” is a dynamic process that results from responses to shared situations and negotiations with other members of that community (Fairclough, 2003; Lave & Wenger, 1991; Shotter, 2011b; Traianou, 2006; Wenger, 1998).

3.2.1 Individual and Community Reflection

As discussed in the literature review chapter, each teacher places different priorities on what they consider makes effective teaching. This usually depends upon how a teacher reflects on their practice (Rodgers, 2002; Shulman & Shulman, 2004). Rodgers (2002) referred to Dewey (1938) who indicated that

“experience is not the same as thought but rather, it is the meaning that one perceives in, and then constructs from, an experience that gives that experience value. An experience exists in time and is therefore linked to the past and the future, [as well as the ‘now’]” (p. 848).

Shulman and Shulman (2004) explain that when teachers discuss their work, they are learning from experiences of their own or from others. Thus, reflection can provide capacity for purposeful change and enhancing teachers’ capacities to learn and develop effectively. Shulman and Shulman (2004) argue that to gain a better insight on the process of what and how teachers acquire knowledge and skill, there is a need to focus on a teacher’s reflection at an individual and a community level as these two dimensions interact with each other and are mutually constitutive. This marks a move from Shulman’s previous studies (1986, 1987a) that had tended to focus on individual, personal practice on pedagogical content knowledge and reasoning. The model that Shulman and Shulman (2004) developed, for “fostering a community of learners” (FCL), encompasses teachers’ reflections at individual, institutional and policy levels. The common-place labels used to characterise teachers' different orientations: visions, motivations, understandings and practices in their model, were adapted in the grouping and reporting of the teachers' ontological accounts of the practical intelligibility of physics teaching both individual and collective. These four elements were taken as follows:

- Vision refers to the teacher's dual praxis: of agency and structures which is demonstrated in their thinking and understanding about teaching and learning. The
vision of a teacher in their work is taken as the intelligibility or practical understanding of teaching and learning as a process and an understanding of the range of activities that may suit a particular group of students.

- Motivation of the teachers in this study was defined as their moral positioning with respect to how they perform their actions socially in terms of physics teaching that underpin their willingness, commitment and persistence towards effective teaching and learning. Motivation may be tacitly or intentionally associated with the teleaffective properties of practices of physics teaching. This is often discussed in relation to a teacher’s vision and understanding.

- Understanding may refer to shared or personal positioning in relation to elements of the knowledge base in physics teaching and locations in the physics disciplinary and interdisciplinary discourses and pedagogical discourses associated with social orders. This knowledge enables teachers to understand what and how to teach as well as transform their vision with issues and topics related to the curriculum and many other factors.

- Practice is the heart of teaching to do with knowing how to skilfully act in particular situations based on the demands placed on them.

Shulman’s early understanding of “practice” (Shulman, 1986, 1987a) emphasises individual over Schatzki’s (2002) “general understandings”. Teachers’ social ontology researched here includes in and outside classrooms that give meaning to and inform and depict their varieties of skills and performances. This is done through looking at their habits of action, habits of interpretation, habits of belief and habits of true belief (Peirce, 1931–58). Thus, the teachers’ accounts of their positioning concerning the “rules” relating to institutional practices and societal rhetoric concerning curriculum, setting assignments, marking, lesson preparations, interactions with colleagues, students and parents are considered as elements in the teachers’ practice and intelligible to them at some level related to their place in the local moral order in their school.

With these four elements, Shulman and Shulman point out each teacher needs to have a capacity to reflect on, and learn from, experiences and supporting purposeful change. According to Day and Gu (2010), it is essential for teachers to be informed about their identity and agency in order for them to be motivated and committed where they could perform their best. As teachers belong to their own communities of practice, they also
consider aspects both of personal and professional development. This can include collaboration, scaffolding and distributing their expertise in the contexts of their social orders as: the practical and expressive orders (Harré, 1993).

Hence, in this study, Shulman and Shulman’s elements of reflection provided a meaningful way to better locate the teachers especially in their own accounts of their epistemic and moral development as teachers of physics in their local moral order. That local moral order as described by Harré, is what makes people’s rights and duties change continuously through social communication. It is through the social interaction that the people are assigned a position or they may explore and select a position for themselves. The positioning depends on context, and a person or character in a particular, and thus their capabilities as “role” bearers in these social episodes. The concept of positioning and the degree of agency, according to Linehan and McCarthy, covers a sense of “oughtness” which accounts for the local moral order (Linehan & McCarthy, 2000).

In addition to the four comprehensive and specific elements of the individual reflections framed by Shulman and Shulman, a teacher’s reflections could also be considered and analysed from the perspective of their illocutionary force or emotional unity (Dewey, 1933). These stances and their social impact in the teachers' personal reflexivity, which are described as conversational attitudes by Rodgers (2002) were:

- **Whole-heartedness**: refers to an honest enthusiasm, engagement, commitment and curiosity of a teacher to the subject matter
- **Directness**: orients a teacher with responsibility which is influenced by own experience and not being too concern with perceptions of others. It is similar to whole-heartedness except that it does not focus on feeling of uncertainty and this make it distinct and crucial.
- **Open-mindedness**: includes the readiness of teachers to accept variety of views and consider the “possibility of error even in the beliefs that are dearest to us” (Dewey, 1933, p. 30); and acknowledgment of the limitations of one’s own perspective.
- **Responsibility**: refers to how the teacher based their practice in relation to the three attitudes of whole-heartedness, directness, and open-mindedness. It is what they
need to confront and counteract the reality of being in the teaching profession with their experience.

The four elements of teacher reflection of Shulman and Shulman and Dewey's four unifying performative discursive stances of reflection, served as descriptive tools in this study of the teachers’ accounts of their physics teaching. This study argues for the importance of the analysis of teachers’ reflective choices in an attempt to understand the reflexivity in teachers’ accounts of the intelligibility of physics teaching. Lifespan research cannot simply take for granted the widespread idea in Western culture that in Australia the teachers each live one “biography”; neither can it proceed by studying “individual lives”. The research problem addressed in this study is that a conversational approach to the study of teachers’ selves and biographies had to be developed. The idea of the teacher's self as a practice theory, with properties of oral stories, involves more than a scientific stance of a physicist. In the end the question became “when and why did these people think of themselves as physics teachers in the way they did in their accounts?” In a post-modern age, when a career in teaching requires continual adjustment to a fast changing or different habitus, teachers’ extended self-reflections in their conversational or cultural circles need to be considered. This includes how teachers see their teaching can be improved and can better display in a semiotic process occurring at a pre-, sub- and unconscious levels (Colapietro, 1989; Hargreaves, 1980). That is teachers’ extended self-reflections may well be aimed to focus for a more practical than the idea that having a "rounded" character.

3.2.2 Teachers’ Practice

The analysis of the teachers’ everyday discourse with the researcher, of their signifying practices, utterances, speech acts, symbols or signs, is subsumed within the temporal processes of doing physics teaching at a particular site. Schatzki (2010a) emphasises the importance of discourse, a point made by both Giddens and Foucault. Schatzki defines a practice as social phenomenon with “an evolving open-ended set of doings and sayings” (Schatzki, 2002, p. 87). He elaborates that what holds and links an organisation of practice together are the properties of “practical understandings, rules, teleoaffective structures and general understandings” (Schatzki, 2002, p. 87) which will next be discussed briefly. Schatzki elaborates that these aspects of a practice can be carried out through habits,
instinct or actions that are learned from past experiences, even if they are not talked about. Furthermore, he describes agency as doing which can be seen to underplay the aspect of conversational interaction.

**Practical Understandings**

Caldwell (2012) describes Schatzki’s practical understanding as “knowing what to do in a particular situation or how to react to ongoing actions” (p. 289). In the context of teaching, it is when teachers know and are able to recognise and act to a teaching circumstance or to students’ ongoing actions. Caldwell (2012) elaborates Schatzki’s practical understanding cannot be guided by formulated rules because “the experience and self-understanding of a participant within a practice carries all kinds of disposition, behaviours, rules, pre-reflexive habits and background assumptions are enacted in practice” (Caldwell, 2002, p. 289). Schatzki admitted and emphasised that it is not possible to fully make out and distinctly explain practical understandings as in the case of this study, by the researcher or by the physics teachers. However, the scope of the description can be extended by taking into consideration of the physics teaching through its context and plausibility. This includes practical consciousness regarding any activity by being skilful or by having the capacity to enact in practice.

**Rules**

Schatzki (2002) takes rules as “explicit formulations, principles, precepts, and instruction that enjoin, direct, or remonstrate people to perform specific actions” (p. 79). Schatzki (2010a) further states, “rules do not determine what people do; rather what people do determines what following rules amounts to” (p. 181). Schatzki (2002) sees that rules can be carefully implemented to social actions as in social life, the formulations are interjected in order to orientate and determine the course of activity (p. 80).

**Teleoaffective Structures**

Teleoaffectivity, as defined by Schatzki (1996) includes “a range of constituents [including] intentions, actions, emotions, and moods as well as ends, purposes, projects, and tasks” (Schatzki, 1996, p. 101). A focus on teleoaffective structure can be taken as a focus on elements of action that are controlled or effected by routinized actions or attitudes, which combine with intentions and goals (Caldwell, 2012). Schatzki (2002) further elaborates that, as teleoaffective structures are distinct from properties of
participants, they are not equivalent to collectively willed ends and projects. He indicates that at any time, provided the practical intelligibility which ground all practices are acted upon, a person does not need to be aware of the teleological end points that determine what makes sense to him or her to do.

**General Understandings**

Caldwell (2012) refers to Schatzki’s general understandings as what “appear to be linked to shared beliefs, goals or values within a community of practice, but it is unclear if ‘everyone’ within a practice shares the same ‘common’ understandings” (p. 291). Schatzki (2010a) elaborates that although general understandings are not “universally shared” within a practice, they could be seen as in this study, as available to and encountered by all teachers of physics. Schatzki (2010a) further explains that in human activity with particular ends and purposes, general understandings are combined with teleology. This provides ways to use and organise objects and circumstances which would specify the structure of activity.

In this study, taking into account of Schatzki’s argument, as described by Caldwell (2012), that practices assume potentially objective and holistic ontological status for teachers, where within the practices, the teacher performs and maintains their knowing as self-organising and immanent. From this perspective, for each teacher, they each learn to practice by doing without the need for theory, reflective insight or as what Caldwell (2012) calls as “cultural constructions ‘inside the heads’ of [the teacher. Thus], practical intelligibility and understanding [appears to] dispense with representational entities that refer to theoretical and deliberative doings based on forethought, rational planning, logic-like rules or reasoned causes [associated with agency]” (Caldwell, 2012, p. 299). However, like Harré, Schatzki is arguing again after Wittgenstein (1958) that the representational use of language is not the way to discuss about practices. Relational uses of language expressed in material and personal grammars are fundamental to the formation of a committed grammar from the good advice teachers are offered. Indeed, in agreement with Caldwell (2012), the indeterminism of personal agency allows for the indeterminate “real world” of practice to happen where meaning and reflexivity inform how a teacher’s agency can be connected to change; transformations both in personal identity formation and organisational practices. This study attempts to better understand the teachers’ agency and their identity formation.
3.3 Methodological Tools

3.3.1 Positioning Theory: Moral Contexts of Intentional Action in Physics Teaching

Reviewing recent developments on the concept of identity and the self led this study to use the discursive positioning approach (Davies & Harré, 1990; Harré & van Langenhove, 1999). Positioning theory, as an approach, allows for the analysis of the intrapersonal and material processes in my research conversations with the physics teachers about their professional identity formation and teacher education. Tan and Moghaddam (1995) discussed the use of the positioning concept in analysing of intrapersonal processes for three reasons, as follows:

First, the positioning concept is a complementary to Goffman’s classical dramaturgical model (Goffman, 1959) on “role” in ascertaining the fundamental element for action. Thus, in this study applying positioning theory affords the physics teachers’ views in locating themselves in conversations which are familiar to them by which they bring their own lived histories.

Second, the positioning concept allows the capturing of more dynamic aspects of interpersonal processes and meaning making. Positioning can be associated with personal identity formation in a field of practice such as in everyday physics teaching. Positioning also includes conceptualising ongoing changing processes and elaboration of a self or self-concept in a given moment or “critical event”. Kelchtermans (1993) indicates that identifying teachers’ critical incidents from teachers’ stories could reveal the ways teachers experience and make sense of the numerous events and happenings during their careers and thus integrate them in their personal teaching style. A person’s life-story justified by reference to personal “critical incidents” is where teachers’ interpretations of critical incidents are considered to be central and enable researchers to understand teacher thought and practice (Goodson, 1991, 1992; Griffin, 2003; Kelchtermans, 1993; Smith, 2001; Tripp, 1994; Woods, 1994, 2012).

Third, “an increasing awareness [of] the existing views of psychology of the self, [though not so evident in the science education research reviewed for this study], tend to reflect contemporary Western, and particularly North American, ideals of personhood [or agency] which [also] transcend cultural limits” (Tan & Moghaddam, 1995, p. 388).
Hence, in this study of the identity formation of physics teachers who are working in Australian schools, the scope of positioning concept is explored through the teachers’ personal view which they can readily explained and shared. This study is also to expand the discussion of positioning by looking at how the culture and the local moral order of the teachers influence their practices. By offering a fine grained discursive psychological analysis after Harré, of discursive and non-discursive practice, I sought to describe how meaning constrains as well as to continuously give way for new horizons within teachers’ thoughts and practice to emerge. That is to describe each teacher’s local moral order of physics teaching by considering their sayings permit language and theoretical discourse to reproduce, or reclaim agency and recover the possibility of change both in the practical social order of practice but also in the expressive social order of honour and status.

Positioning theory has framed the methodology and analysis in this study to help to answer the research questions (Davies & Harré, 1990; Harré & van Langenhove, 1999). Positioning theory enables us to reveal the “explicit and implicit patterns of reasoning that are realised in the way that people act towards others” (Harré et al., 2009, p. 5). This discursive psychological approach to the analysis of the relations between the person and their local order does not exclude the macro-social or cultural context in which it is in fact embedded and embodied. It makes possible the provision of fine-grained descriptions of the meanings that the teachers attach to the actions of others and themselves.

Conversational styled interviews were utilised in this study. These provide opportunities for teachers to explain what is significant to them. These conversations provided several different speech acts including utterances that provided meaning from the storylines. The positioning of the teachers, as well as the meaning given to social discursive and non-discursive acts, including actions, gestures and feelings in the ongoing conversations and classroom observations could make the connections between teachers’ doings and sayings in the hope that both the shared and personal meaningful sense and practical intelligence of their practice could be described (Shotter, 1996).

This study of physics teachers, uses positioning theory to support an understanding of how the teachers’ moral histories (Goffman, 1981) have been shaped in their everyday discursive and non-discursive practices. Teachers’ positions as interpreted by themselves or by others in terms of their “roles” or shared storylines can be claimed as desired identity
(Davies & Harré, 1990). Positioning is an ongoing imminent part of discourse, as pointed out by Davies and Harré:

“An individual emerges through the processes of social interaction [...] one is always an open question with a shifting answer depending upon the positions made available within one’s own and others’ discursive practices [...] Stories are located within a number of different discourses, and thus vary dramatically in terms of the language used, the concepts, issues and moral judgements made relevant and the subject positions made available within them” (Davies and Harré, 1990, p. 46).

As already indicated, Harré and van Langenhove (1999) argue that conversations allow the construction of social world where societal actions are formed and developed. These conversations about self and physics teaching as a social act, are made determinate to the researcher and others in everyday episodes in the mutual relations between the positions the speaker adopts in their storylines and the social or strategic force of their utterances as shown in Figure 3.2. The social episodes of the daily lives of the teachers which result from the action and interaction that shape what they “say” and “do” are a reference to their social illocutionary force. What the teachers say and do when positioning themselves is shaped in the social realities of discursive practices, both inside and outside the socio-cultural setting of their schools. The discursive practice also includes the societal rhetoric that teachers consider has directed their classroom practice. This includes the published curriculum and assessment procedures. The positioning is a relational account of who is doing what to whom in a particular episode.
Within the storylines, that is the narrative being shared by the teachers in their conversations with others including the researcher, their positioning is to be seen as dialogically constructed, and real in that it determines intentionally or otherwise their social acts. Thus, when there are stories, there are interactive positionings and rhetorical redescriptions where they review their own positioning. Positioning theory, as has been emphasised, is an analytical tool that supports a better understanding through interpreting the meaning in the teachers’ accounts of their practices, in speech and action and their interpretation of their rights and duties as a member of their discursive circles. Their social meanings which occur in their habits of action, habits of interpretation and habits of belief are taken here as their everyday knowledge.

Positioning theory as used in this study explores each teacher's social constructivist process orientation. Roberts (1996) proposes a model of social constructivist teaching that he describes as a trialogue. In this study, I have adapted Roberts' model of the three-way dialogue (see Figure 3.3) between the physics teacher, the other he identifies as student where instead in this study is the school which could be students or a science teaching colleague(s) in any of the speaker's conversational circles and the domain as of physics teaching. As the researcher I represent myself in a third dimension engaged in constructing and interpreting the personal and shared knowledge of each teacher. In this three-way dialogue, it becomes clear how a teacher interacts through constructions and representations of self and others, and the physics teaching domain in their shared social context.

Figure 3.2: Mutually determining triad (van Langenhove & Harré, 1999)
This study’s focus has been designed to better understand how and why teachers construct and reconstruct their identities, personally, professionally and institutionally in their communities of practice (Lave & Wenger, 1991; Sullivan & McCarthy, 2004). The *sayings* and *doings* of the teachers were analysed for the meaning of their practices, both discursive and non-discursive, carried for them culturally and biographically. This can be understood by the schematic diagram in Figure 3.4 proposed by Weigert and Gecas (1995) in their attempt to better understand an individual social life within their shared world.

*Figure 3.3:* The adapted version of Roberts’ (1996) epistemological trialogue model of social constructivist teaching.
Figure 3.4: A metatheoretical semantic space for locating social psychologies within the symbolic realm (Weigert & Gecas, 1995).

Acknowledging the limitations of the semantic space in theoretical and methodological approaches, Weigert and Gecas (1995) defined quadrant I as psychological, which pays attention on individual’s being such as their views and beliefs. Quadrant II is biographical, which looks at an individual’s social and historical background that focus on personal histories, life accounts and stories. Quadrant III is cultural, concentrating on the significance of culture on oneself and his or her identities. Quadrant IV is structural, focusing on the institutional and formal structure of social relations and organisations such as the structure of roles, power, authorities and their links to how an individual work and operate within an organisation. Figure 3.4 assists to illustrate in this study in exploring the meanings of the teachers’ discursive practices.

3.3.2 Technologies of the Self

Foucault’s technologies of the self (Burkitt, 2002; Foucault, 1988) are referenced in the analysis of the teachers' accounts to highlight different discursive arenas in teaching generally and physics teaching more specifically. These technologies of the self are "knots of reason" or habitual logic applied by the speaker to themselves to accommodate their local moral order. As an illustration of their use of Foucault’s four technologies are: production, signing, power and self, teachers may describe physics teaching by:

- reference to the need to produce good student results on university entrance examinations, or lessons of a particular type
- reference to signs or symbols of their vision, motivation, knowledge or their practice or of good physics teaching
• determining, interpreting and responding to who is doing what to whom and how, power is used and how they submit or otherwise to certain ends or domination

• referencing operations that allow them by their own means to construct themselves in becoming a better teacher or with the help of others to reach sensible state of happiness or a state of goodness.

However, Heiskala (2011) reviewed that some of the tradition of theories of social action discuss about intentional acts and reflection based on their social actions. These traditions tend to relate to a person’s choices and of why he or she acts on them. Theories of reflexivity had essentially been dealing with how teachers can track down through knowledge and skills of their own actions (Giddens, 1990). Heiskala indicates how phenomenological sociologists such as Schutz have shown crucial indications of how action is comprehensively subsumed and managed by cultural and societal schemes. Heiskala points out the phenomenological sociology:

“…pays great deal of attention to those cultural maps and schemes which define the environment of action to the actor, and it does not understand culture as a uniform code subordinating the subjects but emphasises instead cultural variation between the actors” (Heiskala, 2011, p. 231)

In summary, Heiskala is arguing that the phenomenological sociologists acknowledged that human beings are knowledgeable and resourceful through their regular, normative actions as well as their traditions and customised conducts which are essentially fundamental to reconstruction of society. Although, all these concepts are used with anticipation, there is a need to recognise that human agency also associate with a more customised component. Thus, Heiskala points out that these attempts which focus on “the idea that all meanings are reflective intentional acts, [would then] equip us with too optimistic a picture of the possibility to steer the societal process. This is because all habitualised behaviour [seems to be] reached [by] everyday knowledge (Heiskala, 2011, p. 241). That is, we sometimes allocate the problem to the cause or to the reason which either becomes an explanation and justification for the actions. For example, a teacher may explain and justify his or her teaching as traditional because of the school’s norm. Often in self-descriptions, the teller confuses moral and causal explanations when describing events, where the teller gives objective, causal explanations instead of their justifications (Harré, 1989).
Hence, investigating the comprehensive essence of action and activity is incomplete because the analysis cannot contend with the difference between habit of interpretation and habit of beliefs which Peirce has referred to (Heiskala, 2011). Teachers’ habits of interpretation are often referred to as a result of the local moral order or institutional order of a school. Teachers gave accounts as to what they picked up along the way of their career as a result of working in their own community of practice (Harvey, 2002). Heiskala points out that Schutz and many others phenomenological socialists often took account of actions embedded in culture, and even in this study there is a risk in the tendency to take the teachers’ accounts as habits of interpretation. While on the contrary, the teachers’ accounts could also refer to three other habits. Thus, Heiskala suggests the need to recognise the fourfold distinction between different forms of habits devised by Charles Peirce. They are habits of interpretation, habits of belief, habits of action and habits of true belief. These beliefs interact with each other all the time. In terms of Foucault’s technologies of the self, teachers’ habits of interpretation and belief often allow a teacher to reach a certain state of contentment or well-being.

These four kinds of habits were adapted as follows for analysing the teachers’ stories in this study. As habits of true belief and habits of belief are often intertwined, these two habits were used interchangeably in the analysis of the data and are identified as habits of belief. Furthermore, it is not the main purpose of this thesis to differentiate these two habits as a result of the limited amount of data being collected. Thus, the four habits were adapted into three kinds as follow:

- Habit of action refers to what teachers say they do in their practices and teaching. In this study, a habit of action is revealed when for example a teacher says he or she does lots of group work in the class or get students to do activities the outside classroom.

- Habit of belief refers to knowledge that teachers believe to be true and is relevant to their practices. For example, a habit of belief that many teachers have is that having positive school support makes their teaching more effective and also facilitates good engagement and relationships with their students.

- Habit of interpretation refers to the orientation that teachers take when explaining and interpreting their experiences of teaching and practice. When teachers interpret student’s difficulty arising from a lack of mathematical ability, they are demonstrating a habit of interpretation.
3.3.3 Pronoun Grammar Analysis

The mode of positioning of particular interest in this study is the intentional self-positioning, in which the teacher expresses his or her personal identity. How personal identity can be expressed through indexing one's view of the world and one's responsibilities for action by using pronouns is discussed by Mühlhäusler and Harré (1990b). Mühlhäusler and Harré indicate that we each display the singularity of utilising the first-person indexicals (I, me, myself, my, mine) which assures an individual’s recognition of personal duties and responsibilities for the discursive act. An ability to index one’s account in this manner is an indication of an individual to own personal identity and responsibility. To substitute in a storyline, “I said” of “I did” with “you could” or “they decided” has the discursive effect of distancing the speaker from personal responsibility.

The use of “we” creates a shared singularity of public personhood. Pronoun Grammar Analysis (PGA) has been used to locate the person of the teacher as agent in their storyline and further to identify when the teachers feel personally confident, hesitant or committed in relation to the public practice under discussion (Redman & Fawns, 2010). In this way the teacher's persistent personal identity which is not openly seen by others such as in their own community of practice is indexed in the analysis of their personal realities and their technologies of the self. Their oral accounts of themselves as a physics teacher are also viewed through how they act and relate to other entities, both human and non-human.

3.4 Research Design

3.4.1 Instances

In this study of exploring the identity formation of physics teachers I did not seek a representative sample but rather to present case studies or instances. A total of ten physics teachers participated in this study from state, independent and Catholic schools in Victoria, Australia. At the time of my data collection, some of the teachers only taught physics. Some also taught other subjects such as mathematics and junior science. Two of the teachers were the only physics teacher in their respective schools.

The teachers were at different stages of their careers. Two were in teacher training, four in their early years of teaching and four were experienced physics teachers. Teachers at
different stages of their career were chosen to allow exploration of the social orders that were shaping the intelligibility of practice in everyday daily discursive practices. The experienced teachers were approached from a group suggested by a reference group comprising my supervisors and other science educators at Melbourne University’s Graduate School of Education with knowledge of the population of physics teachers in Melbourne with whom, they have had extended contact some as previous students, some as colleagues in schools or neighbouring schools in which they have worked, some as committee members on the same State curriculum or examination authorities.

The experienced teachers in this study cannot be taken to be representative in a statistical sense. They are esteemed in the physics teaching fraternity, senior in the school in which they were interviewed, approximately 15 years more experienced than the State average and have all completed at least a physics major. The typical senior year physics teacher in Victoria will have completed two rather than three years of academic study in physics. The younger teachers and students in training were approached on recommendation from the population of recent graduates from the Graduate School’s training programme by the same reference group set up for the study. They could then not be said to be representative in a statistical sense of younger physics teachers in Victoria. There has in the last decade or more an increased enrolment into science teacher training in Australia and in other Western countries of second career candidates who have come to teaching in their late twenties and an increased proportion from Engineering rather than Science degrees.

Before meeting each teacher, they were contacted through email or phone. They were sent an email presenting a plain language statement of the study that briefly explained my aims and expectations of them in the study.

3.4.2 Instruments

In preparation for conversational interviews and interpretive analysis I used multiple instruments: questionnaires, Personal Meaning Mapping (PMM), conversational interviews, classroom observation as well as teaching documents (Cohen, Manion, & Morrison, 2007; Creswell, 2003; Falk et al., 1998). The conversational interview was the primary procedure. At the outset, questionnaires were administered to collect each teacher’s personal background such as university studies, years of teaching and their roles
and duties currently performed in their schools. Later in the interviews, the teachers were asked to discuss their expanded curriculum vitae.

During initial conversations, teachers were asked to make a personal meaning mapping. Personal meaning mapping is a tool embracing a combination of mind mapping and concept mapping which can be used to obtain details of peoples’ conceptions and perceptions of their emotions, attitudes and beliefs in relation to learning (Falk & Dierking, 2002; Falk et al., 1998; Giardiello et al., 2014; Rennie et al., 2003). Starting my conversational interviews with the use of PMM allows the teachers to discuss about their practices which included their choices and actions before their teaching as well as their choices and actions during the lesson and after the lesson. The phrase of “physics teaching” provided by the researcher was written in the middle of a blank A4 paper. The teachers were asked to write and even draw anything that came to their mind based on the given phrase in their own words (See Appendix 2 for PMM by one of the experienced teachers and Appendix 3 for PMM by one of the early career teachers). Additionally, school documents and teaching materials were also collected from the teachers when such items were mentioned in the conversations.

In preparing for the interviews I assumed that each teacher would be speaking and acting from an ethogenic position on any issue raised, bringing to certain personal events, in particular as a result of having and engaging in various positions as well as in a variety forms of discourse.

3.4.3 Processes

During my first meeting with the teachers, I sought to stimulate the discussion for why the teachers were interested to be in this study. Often, they saw this question and answered it in relation to their vision and motivation as will be discussed in the next two findings chapters.

The teachers were also asked and encouraged to share a particular critical event or incident that was significant to them in their career. A critical incident could be seen as an experience or event which results in a change of behaviour or a critical moment in a person’s life or in his or her institution (Kelchtermans, 1993; Tripp, 1994; Woods, 2012). According to Tripp (1994), discussion on our past critical incidents are attempts to elucidate, discuss and apprehend our on-going practice and routine. In addition, Tripp
explains how the past could be used to identify practices that have become habits. Habits, as discussed earlier, can be taken as the way how a person, to his or her own context, describes and interprets their actions, practices and even their beliefs.

Hence, in this study, the teachers’ critical events include not only recent events at present days but often were events that have occurred during their teacher training and early years of teaching. Although not all the teachers were able to identify an event which they perceived as significant, they did try to talk about things that they considered as changing or improving their practices.

The PMM discussions were intended to promote an open ended beginning, directed at features of the teachers’ “map” in order to facilitate a conservational mood. The teachers were given an opportunity to explain and elaborate the ideas that they had written in the PMM. It was hoped that the teachers would feel more in control of their stories while I positioned myself as a listener, as a vitally interested stranger from another culture responding to their reflexive positioning and asking clarifying questions about the meaning represented in their sketches. The teachers were encouraged to talk about their relationships with others and pedagogical objects, entities in general things that were important in their everyday practice. I also responded to their questions, clarifying my purposes and encouraging the teachers to talk in greater detail at some points. The PMM discussions, by focusing on the teachers’ subjective accounts, also allowed the researcher to meet the person of the teacher through their own stories and engage in shared meaning making, establishing a rapport.

The conversational interviews commenced from the PMM which extended to past and current practices that provided the link to the teachers’ personal and professional repositioning in their practice. This often arose in the context of discussing the challenges they encountered in their daily practice at different stages in their career or in their teacher training. Additionally, the discussions included persistent issues they were obliged to deal with such as the specific expectations of their students or colleagues or the demands of the curriculum and their school.

The interviews were each of about 45 to 60 minutes duration and mostly took place after school although, when the time permitted the teachers were encouraged to talk as long as they wanted to. The number of interviews with each teacher varied. The number depended
on the availability of the teachers but was, on average, four sessions per teacher. This included one interview explaining their PMM, one prior to and one after classroom observation and one for clarifying any inquiry based on previous interviews, with a brief recall of discussions in previous interviews. The interviews were intended to elicit accounts of each teacher’s identity reflected in the intelligibility of physics teaching as they understood it in their practical *doings* and *sayings*. Each conversation suggested new links in my exploration of the social orders that guided their teaching and how they saw themselves as emergent in relation their previous and on-going identities and practices.

Prior to my classroom observation, the teachers were contacted to ascertain the nature of their lessons. I briefly talked to the teachers before the lesson to be observed mainly to record each teacher's plan and purposes. The classroom observations were recorded in field notes of significant transactions between the teacher and their students. The field notes were used in the follow up discussions when seeking to understand how the teachers’ habits of interpretation and belief about their actions were held in these particular teaching episodes.

The documents collected included copies of the State of Victoria’s prescribed physics syllabus, student work guides produced by the teacher, and students’ worksheets and handouts for particular lessons observed. These were a focus for discussion of the teacher's decisions and choices.

By structuring a sequence of interviews and questions, the teachers were encouraged to describe what is significant to them, the changes that they undergo and to talk about their subject, physics. Attention was given to the changes that the teachers had experienced from their early first years of teaching to their current daily discourse about practices used today. At the same time, as the focus is on the subject that the teachers are teaching, the significance of the subject to these teachers may also explain the teachers’ daily discursive practice. The research approach has been selected to explore the teachers’ stories and to analyse and group these accordingly for patterns and distinctions. Teachers’ stories were gathered in conversational style interviews. Through these conversations with the teachers, I have attempted to locate the teachers’ identities, evident in and from their everyday discursive behaviours; described in their personal positioning, from the institutional practices and detailed in the societal rhetoric and finally found in their choices and actions (Harré & van Langenhove, 1999).
3.4.4 The Phases in the Data Collection and Analysis

Table 3.1 below summarise the stages of data collection and the analysis procedures of the data.

Table 3.1

*Summary of the stages involved for data collection and the analysis of the data*

<table>
<thead>
<tr>
<th>Methods/Data Generation</th>
<th>Data Analysis</th>
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<tbody>
<tr>
<td><strong>First meeting</strong></td>
<td></td>
</tr>
<tr>
<td>Questionnaire</td>
<td>Transcription and coding</td>
</tr>
<tr>
<td>General conversation</td>
<td>Looked for significants stories</td>
</tr>
<tr>
<td>(includes brief history of the teachers)</td>
<td>Prepared questions for next meeting</td>
</tr>
<tr>
<td><strong>Second meeting</strong></td>
<td></td>
</tr>
<tr>
<td>PMM</td>
<td>Transcription, coding and grouping stories using the types of stories (cover, sacred or secret)</td>
</tr>
<tr>
<td></td>
<td>Early analysis on individual transcripts informed the focused questions and some specific questions for each teacher</td>
</tr>
<tr>
<td><strong>Third and fourth meeting</strong></td>
<td></td>
</tr>
<tr>
<td>Classroom observation</td>
<td>Transcription</td>
</tr>
<tr>
<td>(recorded in field notes)</td>
<td>Coding and grouping by using:</td>
</tr>
<tr>
<td>Discussion about lessons</td>
<td>• Shulman’s level of analysis and Dewey’s set of attitudes</td>
</tr>
<tr>
<td>(before and after)</td>
<td>• Pronoun Grammar Analysis</td>
</tr>
<tr>
<td></td>
<td>• Foucault’s technologies of the self</td>
</tr>
<tr>
<td></td>
<td>• Peirce’s fourfold of habits</td>
</tr>
<tr>
<td><strong>Fourth and fifth meeting</strong></td>
<td></td>
</tr>
<tr>
<td>Focused questions</td>
<td>All the analysis tools</td>
</tr>
</tbody>
</table>

3.4.5 Data Analysis

The interview responses were audio-recorded and transcribed verbatim. Pseudonyms were used and coded naming was placed securely in a password computer which can only be assessed by the researcher. The transcriptions were made as soon as possible after each interview to ensure the records were as accurate as possible, and included any significant gestures that were noted by the researcher. On-going validation of my transcripts and data analysis with my supervisors, together with consistent use of definitions for key terms, was employed. A follow-up interview was conducted after each interview in order to clarify meanings of transcribed doings and sayings, and often to elaborate certain interpretations and beliefs. Revisiting the research questions during the data collection
was useful to ensure focused and meaningful analysis of the data. The early analysis of some of the themes and assertions was developed and enriched by subsequent data.

The three types of stories suggested by Clandinin and Connelly (1996) had helped to initially group the teachers’ stories in this study. The stories were grouped according to the similarities and some themes were listed out and categorised during the first phase of the research. The first phase attempted to group and analyse the prominent and commonality among the stories of the teachers. In the process to analyse, the first focus was to obtain a generic sense out of these teachers’ stories which was then focused into the individual teachers’ stories. An initial construction of a descriptive framework of the themes was made as mundane as possible, which needs to be continuously reviewed as more meeting and data were collected. The rewording process was done and continued until a more refined category was produced, which was then categorised using the individual level of analysis of Shulman and Shulman (2004). Recognising the types of stories had allowed the researcher the opportunity to prepare more focused-questions for next interviews with the teachers in order to make the teachers discuss their sacred and secret stories rather than the cover stories.

In the analysis process, some of the early themes and categories of the stories were combined for a better way to describe the teachers. For example, the descriptions of teachers’ vision and motivation were put in one heading, whereas the understanding and practice involved another heading. Further analysis used pronoun grammar analysis, Foucault’s technologies of the self and adaptation of Peirce’s four kinds of habits. The use of multiple ways to analyse the data enable within my limitations of interpreting and analysing the data to generate authentic accounts of prominent aspects of the teachers.

3.6 Limitations of the Study

There were a number of limitations inherent in this study. Within the time limit for this dissertation it was not possible to arrange more interviews and follow-ups with the teachers. This was a problem particularly with the two pre-service teachers whom I was only able to meet two and three times due to their course requirements. Some teachers were more interested in a reflexive journey than others; some were more comfortable in sharing comprehensive, rather than specific, accounts of their constructed experience of physics teaching or its unity than others. Giving the teachers the opportunities to elaborate
their cover to sacred stories ensured consistency in their stories and hence the validity of my data.

This study of a small number of teachers in one city over a short period of less than two years cannot provide a definitive general account of the identity formation of physics teachers; this was not its purpose. Its purpose can be better understood as an attempt to offer case studies of teachers with a different number of teaching years.

Nevertheless, at the same time, to be able to do this study in Victoria, Australia had provided good opportunities and opened up my perspectives as to how physics teaching is perceived by the teachers. Consequently, the new insights I gained from this research provided new perspectives and reflection to my career in teacher training and a starting point for future research in my own setting.

### 3.7 Summary

In this chapter, I outlined a rationale for the discursive psychological ethnomethodological approach adopted in this study. This approach seeks to better understand the participating teachers’ everyday discursive practices by analysing the teachers with respect to their context of both individual and institution levels.

The numerous meetings with each of the teachers except for the pre-service had been useful with multiple instruments being used: questionnaires, Personal Meaning Mapping (PMM), conversational interviews and classroom observation, as well as school and teaching documents. The more stories they shared provided rich accounts into the context of this study to better understand the teachers’ identity. The use of PMM in particular had been a good way to start my conversation with the teachers, because they were free to discuss what they wanted to share and what was important to them, within and informed by the given phrase “physics teaching”. Listening to the teachers had made me appreciate the individuality and uniqueness of each of the teachers.

To comprehensively answer the research questions, the often inter-subjective experiences shared by the teachers of what is it like and how it is like to be a physics teacher were kept central as the main focus in the interviews. In this way, a richer description of what it means to each of the teachers to be a physics teacher and hence a more comprehensive understanding of why they do what they do.
The findings of this study are discussed in the next two chapters, which address not only the teachers’ meaning making stories but also my own interpretation in analysing and presenting the teachers’ storylines.
Chapter 4  Findings of Experienced Teachers

“If we are to improve schooling, we need to discover what experienced teachers have learned from their work” (Wood, 1992, p. 537).

4.1 Introduction to Data and Analysis

This chapter reports on the participating teachers’ storylines, focusing on the four teachers in this study who were grouped as “experienced”; that is those with more than ten years’ teaching experience. The next chapter reports on those teachers who were classified as “beginning teacher” and “early career teacher”; that is those with less than ten years’ experience as practising teachers. The presentation and analysis of their accounts of their teaching and the practical intelligibility of physics teaching were organised according to the four dimensions of reflection described by Shulman and Shulman (2004). The four dimensions: vision, motivation, understanding and practice serve to organise the presentation.

In this social phenomenological study, the ethogenic analysis of each individual’s accounts of their discursive and non-discursive practices is framed by positioning theory (Davies & Harré, 1990; Harré, 1983; Harré & van Langenhove, 1999) and Schatzki's practice theory (Caldwell, 2012; Schatzki, 1996, 2002, 2010a). In both accounts of social behaviour, doings precede sayings. Positioning theory uses the indexical pronouns to psychologically locate the speaker in their own storyline, seen as constructed at the intersection of the private and public psychological space of their teaching. Positioning theory permits a fine grained dynamic analysis of their personal intent, both conscious and unconscious, in each social episode of their interpretation of their rights and their duties as members of their school communities.

Schatzki (2002) points out that practical intelligibility is an understanding of what to do and is realised in practice. Practice occurs in a site of construction, a “clearing” within which a range of discursive and non-discursive possibilities for personal sense-making by individual teachers is provided. This practical intelligibility includes teachers’ understanding of how to employ a particular educational tool, manage student learning and other behaviours in their classroom. Such intelligibility also involves teaching with respect to the normatively prescribed institutional orders of the curriculum and institutional orders in the school, as well as transacting constitutive shared meanings with
colleagues in each of these practices. Thus, what seems distinctively intelligible or practicable to the teachers in their practices, such as teaching approaches and use of curriculum and resources, should be considered when examining the intelligibility of their physics teaching. However, this analysis has been limited to examining those aspects of teachers’ intelligibility of physics teaching that were apparent when the teachers talked about their practice in their responses to the interview questions, as well as during the times I observed of their classroom teaching.

The storylines for each teacher were presented in multiple, lengthy, semi-structured conversational interviews with the teachers. This includes observations of their teaching. The conversational interviews focused on not only teachers’ accounts of their early years but also their current and on-going experiences. This was hoped to better understand their development in their practices. The teachers were clear that their teaching had changed and offered a range of influences on their practices. The interviews have sought to explore these links between teachers’ accounts of their classroom actions and how they are positioning themselves in their stories. Classroom observations of their teaching practices provided insight into how a teacher’s account of their classroom actions related to their actual practice. These interviews and classroom observations are juxtaposed and enable a fine grained analysis of both the practical and expressive social orders (discussed in section 2.1) in the teachers’ accounts, as they restricted or expanded their capacity for purposeful change. The research seeks to inform an understanding of the teachers’ capacity and influence for purposeful change.

The sequencing of the Shulman and Shulman dimensions from vision to practice implies a conventional cycle of rational analysis. This is not my intent. “Practice and Understanding”, could just as easily have been treated before “Vision and Motivation” in the presentation of each teacher’s account of their identity formation as a physics teacher. There are overlapping features and relationships between these four dimensions of reflection. Broadly speaking, some boundaries distinguish the dimensions. The qualities of directness, open-mindedness, whole-heartedness and responsibility suggested by Dewey (Dewey, 1933; Rodgers, 2002) have also been used to effectively characterise each of the teacher’s reflections on their daily discursive practice.

In presenting the data, adapting Shulman and Shulman’s grounded view, in the domain of physics, the “vision” of a teacher pertains to their personal goals about the best that
could be attained in his or her future classroom practices. “Motivation” of the teachers in this study has been defined as what influenced the teacher’s willingness, commitment and persistence as they strive towards effective teaching and learning. The “understanding” dimension is a complex and large category. This dimension conventionally covers the representational knowledge domain of “what” is expected of a physics teacher, less frequently the dispositional knowledge of “how” and infrequently the knowledge from within which is to do with “values”. All are related and have pre-phenomenological elements that can be drawn on in any practical situation. Identifying a teacher’s understanding was problematic for two reasons. Firstly, discussing their personal understanding of theoretical physics or physics teaching, which is not a normal part of a teacher’s everyday discourse, could be seen as threatening to their self esteem. Secondly, knowledge claims would not be easily distinguished from descriptions of their vision, motivation or practice. For example, a teacher who is asked about his or her understanding of good teaching is likely to discuss vision, values and motivation from the perspective of his own practice.

Furthermore, spatial and temporal distributions of the teachers’ agency in their signing and gestures in their daily activities must be regarded as being part of the “understanding” dimension. Schatzki states, “Teaching, …occurs in space, in various temporal manifolds, in the educational practices of a given school, in the history of education in a given country, and so on” (Schatzki, 2000, p. 23). In this study, “understanding” was located and identified in these teachers’ discourses around their sense of agency of both the spatial and temporal dimensions in their various personae as physics teachers and their other role bearing. The roles include being a school staff member, school science and/or mathematics staff member, Year 12 Victorian Certificate of Education (VCE) physics teacher, school physicist, student mentor, together with other general specific and unique identities inside and outside the school.

“Practice”, the fourth dimension of reflection was seen as embodying agency and involving all of the other dimensions, but focused more on their positioning behaviour as it related to the local moral order or institutional norms in their school. The teachers are also reflecting their practices on the often unspoken societal rhetoric. Their reflections on their practice reveal the practical intelligibility of physics teaching in each of the four areas Schatzki (2002) defines (discussed in section 3.2.2): “practical understandings,
rules, teleoffective structures and general understandings” (p. 87). These four areas are integral to their daily enactments of various specific duties and responsibilities, the school and physics curriculum, examining marking, setting assignments and lesson preparations. Practice will also include the teachers’ more episodic, direct and indirect interactions with colleagues, students and parents at some level in relation to their place in the local moral order in their school.

The Pronoun Grammar Analysis (PGA) locates the person as agent in their own storylines and positioning in each social episode. The use of PGA assisted in illuminating and interpreting the teachers’ “technologies of the self”. All pronouns, as well as some qualifying words such as “actually” and “really” in the quotes from all transcripts of each teacher’s interview, were underlined and highlighted to show the original analysis undertaken. Nevertheless, in the discussion and analysis of the data in this chapter and the next chapter, the PGA was conducted, but referred to only some quotes that highlighted and identified the significance of the teachers’ stories and to their roles and sense of agency. The PGA locates the individual in their own storylines, and the range of positioning possible and available in each conversational episode. The teachers’ stories were further considered and interpreted in elaboration with the use of Foucault’s technologies of the self (Burkitt, 2002; Foucault, 1988).

In addition, the fourfold distinction between different forms of habits devised by Charles Peirce (1931-58) was adapted for analysing the teachers’ stories in this study. The four habits are: habit of interpretation, habit of belief, habit of action and habit of true belief. Identifying these habits within the teachers’ habits of description and explanation, in subscribing to norms of their physics teaching practices in their school and other discursive communities, helps to better understand the teachers’ positioning. However, habit of true belief, that is beliefs they sought to verify in accounts of their experience, and habit of belief, are often intertwined. In this study, these two categories of belief were collapsed in the analysis of the data and are identified as habit of belief.

The analytical and categorical tools: Shulman and Shulman’s reflection dimensions, Mühlhäusler and Harré’s indexical pronoun grammar, Foucault’s technologies of the self and different kinds of habits have been applied to better understand and describe the practical intelligibility of physics teaching and the tensions in learning to teach physics.
and the development of a teaching identity. These tools were used to explore three research questions:

- What personal and social meanings do the participating teachers attribute to their practice as a physics teacher?

- How do the teachers position and reposition themselves in their accounts of their practice, in relation to the norms of senior physics teaching and, more generally, teaching in their schools and beyond?

- How do these teachers describe the processes which have contributed to their professional identity formation as physics teachers?

### 4.2 Nelson

#### 4.2.1 Introduction to Nelson

Nelson is an experienced physics teacher of forty years. At different times, he has held many leading roles in schools including that of principal, curriculum director and science coordinator. He entered teaching with a bachelor of science degree and graduate diploma in education in the 1970s. I first met him at WT School located in the suburbs of Victoria. At this time, Nelson had only been at the school for three years. Prior to WT School, he had been a principal of another school and had also worked at a state curriculum authority responsible for curriculum design.

The following year after I met him at WT School, I met him at another state school in another suburban area, EB School where he was teaching physics Year 11 and 12, and science and mathematics at the middle school level of Year 10. He was enthusiastic about his new school although he indicated he felt some “frustration with the school administration” which expected him to teach in a particular their way. He indicated he did not entirely follow “what was expected of him” because he considers his own approach to teaching, whereby his focus is on generating conversations with his students, is successful and works for his students. He commented:

This school [and] lots of [other] schools and lots of classes are fairly orderly controlled and contrived and discipline is the most important thing. The classrooms in this school are all very controlled and our curriculum coordinator and the principal wanted us all to do the
structure like walk in, tell the kids what the aim is, get them excited about something, then move on to this, then move on to this and [move on] to this and then come back with the evaluation [...] Now, I don’t do that in my class. I expect the kids [...] to talk to me. They are some really good conversations. So I basically spoke to every kid in the class [Nelson, 4, 10]

Note that in the quote above and for the rest of every teachers’ quotes in this and the next chapter, the number in the square bracket after the teacher’s name represents the nth session of the interview with the teacher and the last number referring to the nth line of the quote in the original transcript.

**Vision and Motivation**

Nelson’s stories consistently linked to his long-term vision that, through physics, he was affording his students a holistic education. This vision seems to have guided him throughout his career and is consistently evident in his interviews. His stories, as illustrated in the following quote, demonstrated his broader vision for his teaching. His vision went beyond the transmission of the physics knowledge in the prescribed curriculum for examination purposes, and he is trying to achieve this through his sense of agency. Note that, in Victoria, Australia, all students study a general science course at Years 7 to 10. During the post compulsory schooling, Years 11 and 12, studying science is optional, those available are discipline specific such as physics, chemistry and biology.

I want to teach something where I can give the kids a really good sense not just of the subject but why we are doing it and how it operates and not just that sort of mathematical modelling. In Year 7 to 10, you get, particularly a very important component for a well-informed citizen and by the end of Year 10, there’s a lot of kids who couldn’t really care about doing science at all and so how do you enter into that [site] in a way that will honour what they are, who they are becoming and at the same time giving them some physics in there? [...] and even from Year 11 and 12. A well-informed citizen must be able to use data well, understand data and the nature of it and be able to evaluate [Nelson, 1, 98]

Using PGA, highlights how Nelson positions himself personally (“I”) and with a collectively of uncertain membership (“we”), with a broader educational purpose for science teaching, a position expressed by Schwab (1978) of how we know to do thing and how we value it rather than just communicating what we know. As per Schwab, Nelson was emphasising the significance of educating for an appreciation of science as a human enterprise and an enquiry based education for “intellectual autonomy and moral agency” that was part of the societal rhetoric of the Physical Science Study Committee (PSSC) physics course, which, as will be discussed later, was a strong influence in the physics curriculum in Victoria in the 1970’s when his teaching career began.
Nelson also showed his technologies of production (Burkitt, 2002) where he was able to produce and manipulate his teaching styles, based on what he identified as the needs of his students.

It is that moment or that process by which you shake out of these kids to the point where they actually feel that they can take charge of and see the excitement that they can take charge of their own learning. That’s what I’m trying to do. I don’t care about the physics stuff [Nelson, 4, 419]

In the above quote, Nelson states “I don’t care about the physics stuff”. At first glance, he seems to contradict his earlier quote concerning his desire to give his students a good sense of the subject. However, Nelson’s point was that he was not particularly concerned about which ideas his students should learn, as long as they developed an understanding of whichever ideas they cared about, and studied and understood why they were being taught the subject. Furthermore, as evident from the above quote, Nelson’s stories highlighted how he achieved his vision. He stated the importance of him regularly engaging in meaningful conversation with his students, and often giving them opportunities to immerse themselves in deeper thinking, about physics concepts. Nelson sees this as not only for the purpose of developing an understanding that would enable them to pass an examination, but, more importantly, to satisfy their curiosity and need to know. This process, Nelson thought, often resulted in his students being more appreciative about how things around them worked. For Nelson, these regular conversations between him and his students helped to make his students aware of, and assisted in achieving, his intentions and visions for them as students in his physics class.

Nelson’s consideration of the importance of having regular conversations with his students confirms teaching is a teleoaffective practice for him. That is, he considers his teaching actions are broadly intended to meet acceptable ends in educating and fulfilling holistic education of his students through their physics learning.

In addition, Nelson stated that his childhood influenced his teaching vision. When growing up, he was involved in many community services and held a leadership role in his local church as a young person. From a young age, he took on the rights and duties of being responsible for educating others. He articulated his role in promoting this holistic development of his students.
I was running the local church [group] when I was 12 that I was in my first year at high school, I used to go down with my own program plan because the man who was supposed to come often didn’t arrive so there were 20 kids there with nothing to do so I used to run that [Nelson, 2, 274]

Nelson portrayed himself as being a person with a vision of life-long learning that began early in his career, when he first held a leadership role as evident in his quote below.

As a new coordinator I read everything. I went to all training that I could and I became highly committed to trying to deal with this; how do we get kids to understand and then I started to have some, not so much success […] The joy is when you started to see kids shift their mind, shift their paradigm, of how you want them to go about learning. Once they’ve got that, I don’t care if they are learning anything from me at all but whether they shift away from where they go about learning and doing something really, really significant for them as a human being, so that’s what I’m looking for [Nelson, 2, 365]

The above quote is significant in revealing his willingness to explore new ways of teaching. It also shows his motivation for teaching, which seems to stem from the satisfaction he feels when his students eventually understand what he wants them to know and learn. This aligns with his sense of obligation of his students’ rights to be successful in developing their understanding. This motivation has also informed, over time, his choices and actions in the classroom. This connection between motivation and satisfaction, when students’ learning is successful, was identified and mentioned by most of the teachers who participated in this study.

**Development of Practice and Understanding**

Nelson considers that his teaching approaches have been refined throughout many years of experiences. He recalled his early years when he regularly asked himself what he really wanted to achieve in his teaching and for what reasons. It seems that from early on in his teaching, Nelson was reflecting on his own practice. He put extra effort to improve his practice even more as he undertook leading roles very early in his teaching career, when he was in a disadvantaged school setting. He took responsibility, as a duty for leading roles, which included being a coordinator, senior teacher and eventually a principal as well as extensive involvement in curriculum design and as a textbook writer. He demonstrated wholeheartedness in his development as a teacher. He enacted his right to be supported by others through continuous discussion with colleagues who helped each other. He was driven to read widely about constructivist teaching approaches. He introduced constructivist teaching approaches into his classes and started to see the impact it had on his teaching. This, he stated, led to his students’ better understanding and
learning about physics concepts. This was apparent in the following quote, which indicated his own efforts to develop his career.

I taught myself pretty much the constructivist way from about 1985 onwards [...] My first year I moved immediately after that to a disadvantaged school and I suddenly found myself jumping into holes because there were no teachers [...] so I found myself doing the Year 7 coordinating. By second year, the maths coordinating, the camp coordinating, helping with the new set of programmes and a whole range of other things cause nobody was there to help, to do these things. So I had all these, very early career leadership experiences [...] but I very soon became a senior teacher, which means I was now doing student management as a major task [Nelson, 3, 184]

Recalling his early years that involved many coordinating tasks, Nelson now sees managing students as the main task expected of him as he becomes more senior and experienced.

In his discussion about his practice, Nelson places a priority on provoking his students’ thinking in order for them to really understand why they have to do what he asks them to do. This was seen in one of the observed lessons where he changed his plan for the lesson. He decided to do this because at the start of the lesson when he tried to make the students to recall the topic, “motion”, from the previous lesson, he found out that as revealed by his students’ answers, that some of them were still unsure about the concepts in the topic. Hence, instead of continuing with his planned lesson, he encouraged his students to do further investigations on the topic. He provided his students with more time to answer and explain their reasoning in their own words, and encouraged them not to rely entirely on the formula. His argument for this was that he wanted to create a chance for his students’ thinking to develop, as he understands this is a student’s right to learning.

As discussed earlier, and as mentioned repeatedly throughout his interviews, Nelson knows the process of spending time in conversing with his students, about why they are learning physics, is difficult. In the quote below, he emphasised his point with his use of qualifying word “really” triple times. However, his use of “you” instead of “I” seems to indicate his expectation for a teacher to do the same thing. He recommends the need for a teacher to be persistent in placing a priority to regularly engage in conversations with students although the process will take time and extra effort to be seen as effective. He considers this as his duty to his students. He said:

Well you have to be pretty well persistence, you have to be thick skinned, you are likely to get a few kicks from your administration because the class does not go as well. It’s really
really really difficult until you actually settle down and people know what you are about [to do] and they’ll leave you alone. It takes quite a lot of your effort [Nelson, 2, 522]

It is evident through his emphasis in his stories that Nelson tries to engage his students in conversation regularly and as often as possible. He perceives that through these conversations, his students can see and value why they need to know and understand what they learn. At the same time, Nelson perceives that the conversations allow students to develop a better understanding of the subject and, as a result, they are more able to answer physics questions themselves rather than him providing all the answers. Consequently, Nelson’s habit of belief is to understand his individual students’ needs and this habit describes his teaching choices and actions. He implements and applies certain teaching approaches in his classroom that suit his students; approaches which need his judgment as to when and how to use them. This point was similarly emphasised by the other teachers in this study, particularly by William. Nelson is cognisant of his rights and duties and those of his students and this informs his practices.

As seen in the quote below, Nelson highlighted that the structure and planning for a lesson should provide for explorations of his students’ thinking rather than just instructions on what to do. He believes this is crucial in order to make students more engaged and to enhance their learning abilities.

I’m not opposed to the notion of the structure of a lesson […] Well-structured lesson, it makes good sense for kids and kids actually learn better that way but I want to go inside that lesson and inside the kids’ [heads] and ask the question about what’s happening for the kids? Are they are being imposed to socialise then to follow the rules or are they actually being asked to really struggle with something and engage with it and tweak their own minds rather than being told what is it they are to be doing [Nelson, 2, 218]

Nelson thinks that a teacher’s character and the culture of a school influence a teacher’s practice as evident in the two quotes below. His use of “you” indicates his referent to teachers in generally, rather than speaking specifically about him.

It’s all the influences around you and it’s all the person that you are and how you interact with what surrounds you […] it depends a little bit on what an individual person is looking for [Nelson, 2, 407]

The culture of the school and the control over and the expectation for the children [is influencing a teacher] because there will be fifteen [children] in the class and each one is different but you still have to make yourself creditable. At my age with my experiences, you still have to make yourself creditable and […] that’s very difficult [Nelson, 2, 529]
As the above second quote demonstrates, Nelson also regards differences in students’ characters as informing a teacher practice. His use of “you” indicates his view for teachers in general, however, his referent to his age and experience also indicates his point view as well, where he acknowledges even with himself as an experienced teacher, the importance of finding ways of achieving creditability with the students in order to be successful in the classroom.

Nelson’s general views about what shapes his teaching, as with many of the participating teachers are aligned with the literature (Mansour, 2009) which indicated teachers’ practices are situated and informed by influences arising from various levels and sources such as the classroom, the school, the community and thus the culture.

The following quote serves to strengthen Nelson’s point of view that he is provoking students’ thinking through conversation, and also demonstrates elements of the “understanding” dimension as described by Shulman and Shulman (2004).

I’ve become more and more convinced that you actually have to unpack the status of your explanation and the quicker you do that, the earlier you do that with students, the more chance you’ve got of opening them up, and they can be flexible thinkers [Nelson, 2, 129]

Clearly, Nelson has developed an understanding of teaching and learning physics that strongly influences his practice. For him, it is not sufficient to merely provide students with scientific explanations. Rather, he sees that students need opportunities to discuss their own ideas and to be able to recognise and understand how their ideas are similar or different to scientific ideas. Observations of Nelson’s teaching practice were consistent with what he shared in the interviews. He shows a good understanding of teaching physics that he admitted had developed over time, as a result of his leading roles such as being a coordinator and science manager. Having held these responsibilities has informed and impacted on how he approaches his teaching. He understands that learning and teaching in a classroom is a process not only for his students but also for his own development as a teacher (Shulman & Shulman, 2004).

A significant comment from Nelson below was made when he compared physics to the other sciences in relation to the emerging nationwide curriculum for Years 11 and 12 that was developed at the time of my interview with him.
I’ve watched, I compared now the physics curriculum that is emerging with the chemistry and the biology and the environmental science, all of which have fairly good curriculum you know if you be critical of them but it’s only in physics where [...] we interrogate [...] where we would argue that you need to go beyond that of where does it come from? How that arises and how that opens up the understanding of the way we do physics and then, how that also helps us to understand [...] So chemistry tends to take for granted the explanations, biology is the same you know which of this is true - it’s not interrogated for its truth value. Yeah, so physics is the only one that is making an attempt to interrogate the truth value of its own statement and to interrogate the processes by which those truth values [and] truth statements are in fact established and how they undermine the change; which is really the big issue for understanding the nature of the enterprise of science so that’s what we’re trying to do and that suits me very much because I’m not a gadget person you know I like the idea of what people think about within an idea[Nelson, 2, 131]

The above quote is consistent with Nelson’s positioning about what he views as the goals of learning physics. The quote also demonstrates his awareness and understandings of the nature of physics, and what distinguishes it from other sciences, particularly in terms of the current demands of the curriculum, and how these distinguishing features influence his physics teaching.

Again, using PGA, Nelson showed his control and power regarding the curriculum he wanted to teach with his use of “I” at the start of the quote. When he switched to “we”, he indicated that he was acknowledging himself as belonging to a group of physics teachers and physicists of similar understandings and aims of doing physics. Later, he switched back to use “I”, which indicated his personal view was not necessarily similar to the group of physics teachers that he belonged to. Using Foucault’s technologies of the self analysis, Nelson reveals his sense of agency in signing what physics teaching is to him, in comparison with the other sciences, and how his views may differ from those of other physics teachers. He also showed his technologies of power and feeling of the self in what he was doing.

In addition to the recognised importance of teachers continuously building on their knowledge through discussion with colleagues and professional development activities, Nelson also made efforts to read as much as he could. He found that reading relevant materials associated with physics teaching from educational sources such as journals had helped him to develop his understanding and knowledge about teaching. Nelson referred to this activity repeatedly, in particular when he recalled how he had explored and developed new ways of teaching, as explained earlier.
Midway through his teaching career, Nelson did a masters degree that helped him to update his content knowledge and as part of his life-long learning. He noted that although teachers’ pedagogical knowledge was often updated through attending professional learning sessions, this was not the case for their disciplinary knowledge. Hence, he thinks it is necessary, especially for teachers who have studied their disciplinary degree a long time ago, to be given opportunities to update their subject matter knowledge.

It was noted earlier that Nelson held strong views about the nature of physics and how it differs from other sciences. Nelson studied the history and philosophy of science in his undergraduate degree. As the quote below demonstrates, he thinks that knowledge of the history and philosophy of science has been an important factor influencing his physics teaching.

\[ \text{I’d been through professional learning activities… so yeah all of that has informed me and the other thing that informed me about the way I was teaching, of what I want to teach…was I did history and philosophy of science in the university [Nelson, 3, 211]} \]

Nelson indicates a habit of belief concerning knowledge about the philosophy of science and knowledge about the history of science and physics, which have helped him, develop a clearer understanding of the nature of explanations. This has supported him in both practical and theoretical aspects of learning physics and additionally had provided answers to the puzzles and questions about science that he encountered. His great interest in, and focus on, the history and the philosophy of physics has informed his teaching, and also predisposed him to be interested in the nature and philosophy of learning and teaching.

In terms of his pre-service teacher training course, Nelson considers the course was lacking in addressing philosophical issues of teaching and of science that are relevant to physics teaching. This lack was particularly evident when considering the links between approaches to teaching physics and understandings of the nature of physics. He thinks current teacher education courses also fail in this respect. Nelson considers himself fortunate to have studied the history and philosophy of science during his undergraduate degree. Furthermore, he sees that having families and friends who are also interested in the philosophy and historical knowledge have continuously formed and equipped him very well throughout his teaching career. His habit of belief is that teachers who are
equipped with knowledge on the philosophy and history of physics are effective in their teaching.

Consequently, reflecting on what has been important in his development as a physics teacher; Nelson wishes to see the philosophical issues and the history of science and of physics forming part of class discussion in every physics methods class. Nelson thinks it is essential for beginning teachers to gain knowledge about the history and philosophy of science during pre-service teacher education as illuminated in the quote below.

I think that what every teacher needs to have is a very strong philosophy of science. I think you actually need to put it in your course. I think the absence of the cut and thrust of the philosophical discussion in teaching is a sad reflection, because we don’t have the tool then to break out of the moulds that we are in [Nelson, 4, 220]

Nelson thinks that when a teacher has a better understanding of the philosophical aspects of science and physics, then he or she is able to move away from the traditional approach of “mathematising” physics teaching; an approach that relies on formulae for explaining the physics concepts.

A large number of physics teachers had mathematised the [physics] courses. I hate about going to here’s the book, learn the book and the things that worries me about a mathematised classroom is that it’s all about that “I’ve got the authority to tell what you have to do every steps along the way”, instead of you take your own command of your own ways into this […] Focus things into these kids’ head until they realise they got to do more than just a piece of just a structure of authority of your [teacher] function [Nelson, 2, 427]

The above quote clearly shows Nelson’s personal philosophy does not support a mathematised approach to teaching physics as this reinforces the perception that a teacher controls the learning in the classroom. Nelson states that a lack of knowledge of the history and philosophy of physics is likely to contribute to the traditional emphasis in teaching physics on solving physics problems using algorithms and doing practical work to verify physics ideas. He is concerned with physics teachers who teach physics in a form of mathematics by solving problems using formula as well promoting a view of physics as being “discovered” in the way they implement practical work in their classrooms. This means students conduct many experiments without having a proper understanding of why they are doing what they are doing. In particular, he is concerned that such approaches promote poor learning behaviours and dependency on the teacher. It was evident from my interviews with Nelson that he considers learning is more powerful when students take control of the process. For him, students’ learning is not a matter of just absorbing
information from their teachers, but for students being actively and consciously engaged in their learning. This seems to be a shared view, as other teachers in this study, in particular William, John and Mark who emphasised the process of learning as a responsibility for both teacher and students.

Using Foucault’s technologies of the self analysis, Nelson showed how he is able to sign and produce his teaching over the traditional views of teaching physics in mathematised ways in order to meet his personal philosophical views. He showed a well-developed technologies of the self, whereby he finds his teaching effective when he allows his students to take control of their learning.

Nelson’s stories repeatedly emphasise the importance of physics teachers having a network with their peers and on-going support. He has experienced this for many years, such as through a one-day professional learning session in his school or at the Physics Teachers’ Conference, an annual conference in Victoria, Australia organised by the Science Teachers’ Association of Victoria (STAV). This association aims to support science and science education.

Nelson and William, another experienced teacher, elaborated on the importance of beginning teachers receiving support in the first few years of teaching in order to better develop their practices. Both Nelson and William highlighted team teaching as one of the better ways to support these teachers. They also emphasised the need for teachers to be independently and continuously be active in learning from others, as well as reflecting on their own experiences. This point relates to issues that were mentioned by some early career teachers, and which are discussed in the next chapter. For example, Maria, one of the early career teachers in this study, and who has changed schools each year since she started teaching, stated she faced difficulty in getting sufficient support.

Nelson pointed out that teachers need to have quality support in many aspects of their roles. In the following quote he gave the example of constructing test items, a task which many beginning teachers do with limited or no support because there is no other teacher in the school who can help them.

Most of the teachers are very poor in constructing in terms of writing test items for instance, and they have to do that on their own because nobody else is working with them, as there is only one [physics] teacher in school [Nelson, 2, 415]
Furthermore, Nelson feels that even when teachers in schools do talk with each other, for example in a staff room, most of these conversations are generic. This worries him when there is only one physics teacher in a school, a common situation in schools in Victoria. Nelson indicated often the only physics teacher in a school faces a lack of support, especially in term of developing physics pedagogical content knowledge. Generic conversations about teaching also worry Nelson when beginning teachers have developed the view during their training that there is a standard way of teaching regardless of the subject being taught; for example, thinking that teaching biology is no different to teaching physics. These concerns are expressed in the quote below.

There’s a lot, I mean the conversations in a staff room or in the school is always generic […] so everybody can teach the same and..my DipEd and my MTeach students, they tell me that anybody can teach physics because it’s only matters of generic skills […] that is what she said that she picked up from one of the lecturers, not the physics lecturers but that they will see that it doesn’t really matter. There is a standard way of teaching and if everybody follow that standard way of teaching, they could teach anything, I mean that’s absurd nonsense [Nelson, 2, 485]

The above quote provides evidence of Nelson’s strongly and personally held convictions. He talked predominantly through “I”. That is, he talked from his heart and revealed the strength of his whole-heartedness and commitment to what he is doing in his practices.

Nelson considered his physics teaching was influenced by the introduction and implementation of a physics course which was developed in the United States by the Physical Science Study Committee (PSSC). PSSC was introduced and adapted in Victoria, Australia in the late 1960s. The PSSC programme was written by physicists and science educators and designed to give students the opportunity to gain understanding of the physical world and conceptual structure of physics by developing relationships between experiment and theory (French, 1986; Matthews, 1992). PSSC provided an approach to the subject matter that could be linked and provided a shared vision of science at its best, with connections among many fields (Holton, 1978/1998b).

PSSC gave Nelson a perception about the structure of physics that was very useful to use when teaching physics and its introduction to Victorian schools was accompanied by considerable support in terms of textbooks and professional support for teachers. Nelson recalls that some of the very experienced and young, excited physics teachers at that time were made to work together, resulting in the formation of VicPhysics. VicPhysics is a
support network for physics teachers in Victoria handled by the Australian Institute of Physics (Vic Branch) Education Committee.

So what Victoria did in 1965 […] was they targeted some very experienced teachers and some very young well-known excited teachers. They were obviously doing well across the system. They put them together and they gave every teacher of physics ten days full-time training in the new course and then they provided the expert backup service afterward to help these people which is why you now got that VicPhysics website [Nelson, 3, 390]

The VicPhysics thing and the cooperation that has occurred between physics teachers in Victoria starts, really starts with the PSSC and the networking and the support that were occurred then. And that incredible will of people to want to cooperate with physics teachers as much as possible, so what we need, we really need a model of that sort [Nelson, 3, 412]

Currently, Nelson considers, the support network is not as dynamic as it was when it was first introduced. He thinks the network should be more active in assisting new physics teachers to get connected, be supported and to learn from each other. This is a similar concern raised by Kate, another experienced teacher.

4.2.2 Summary of Nelson’s Narrative

Nelson clearly sees learning to teach physics as a lifelong endeavour that requires ongoing support. His vision to provide his students with a holistic education through his physics teaching was seen clearly in his stories. He expressed a sense of great responsibility, in his duties to ensure his individual students’ academic growth, not only intellectually but also morally, as he contributes to his students in becoming a society of well-informed citizens. Listening to Nelson’s stories and observing his teaching, one becomes aware of his great commitment and sense of responsibility in his work and how his awareness of his rights and duties can be seen to influence his relationship to his students and hence his teaching. He is open-minded to any changes that he perceives bring benefits to his students, which is a consequence of his attitude of wholeheartedness towards his responsibilities for his students.

Nelson’s habits of belief of good and effective teaching and learning physics reside in his continuous conversation with his students. His habit of belief coincides with his habit of interpretation where having conversations with his students work well in his classes which then influenced his actions. He responds to and understands his students’ rights and duties.
Nelson’s discussion and description of his teaching practices reveal aspects of the development of his identity as a physics teacher, and of his intelligibility of physics teaching, in terms of vision, motivation, practice and understanding. He is reflective in terms of his vision and understanding of teaching and this informs his teaching and classroom actions. He voices his stories by reflecting on and through discussing memories of his development and practice. His stories were not only of physics teaching, but also of the wider purposes of teaching and learning in general. His views are emphasised through his habits of belief on the importance of the nature and the philosophy of physics knowledge for teaching and learning to take place effectively. His habit of interpretation about what works best for him and his students indicates his habits of belief have intertwined with his thinking and attitudes to his daily actions.

4.3 William

4.3.1 Introduction to William

William is an experienced teacher of thirty years at CH, a private school. He has also taught at the tertiary level. He is widely recognised as a skilled teacher, as demonstrated by his roles and responsibilities he has had or currently held which include head of science and director of professional development and director of studies and curriculum. He has been a textbook writer and had significant experience working in an official capacity in the VCE assessment process. He has an experimental physics higher degree by research. He talks openly about his teaching experiences, in particular about what he thinks is good physics teaching. He was able to articulate stories that display his great motivation and commitment in his work. His genuine care and interest in his work as well as in his students’ welfare are evident throughout his stories.

Vision and Motivation

William indicated that although he did not have any role model or inspiration to look upon when becoming a teacher, he always knew he wanted to be a teacher because he likes to interact with people and through teaching he could continuously learn.

I like interacting with people. I like seeing them and say “oohhh” […] The [motivating] thing about teaching is when you engage in a common quest with your student [William, 2, 116]
In the above quote, William’s remarks display his commitment and enjoyment in his work when students show they understand what they learned. He sees their understanding being developed through forming a “learning relationship” with his students, as will be discussed later.

William portrays a clear vision for his work as a teacher through his comments that concerning his interest and motivation. He is interested in actively looking for ways to develop his teaching strategies and to learn new ones. William recalls he was motivated by listening to people with good and powerful ideas at professional learning workshops he attended as well as by observing how other teachers teach. Such experiences not only reinforced his motivation to be a teacher but also more importantly improved his understanding of how to be effective in his teaching practice. He clearly shows his commitment and responsibility as a teacher to developing ways to teach better.

In particular, learning how students learn best has helped him to teach more effectively. PGA in the quote below highlights how William uses “I” to signify his personal interest and his effort to increase his own knowledge in psychological aspects of learning.

If I hadn’t been to the session with [the educationist] Julia Atkin on how the brain works, I wouldn’t and I might not have thought about it as quickly as I have [William, 2, 382]

In the above quote, “it” refers to how William’s responds to the individual needs of his students. His account of this session, which was a significant event in his career, illustrates the development of his practical understandings about individual students’ needs and psychological aspects of their learning. His motivation to learn about how his students learn has led to his better understanding of how to deal with and manage time when responding to the individual needs of his students. He stated, as seen in the quote below that he makes an effort to spend time with individual students in order to find out about each one of them.

Learn their names. Amazing how that can support your teaching. Taking interest in their courses in their lives and be available on email, occasional tutorial before and after class and not rushing to finishing [William, 4, 11]

Although his account above is a cover-sacred kind of teacher story, for William teaching is being able to provide learning and academic growth for his students and so prepare them to participate in the real world beyond school. The significance for William of his learning about his students indicates teaching is a teleoffective practice for him. In
Schatzki’s term, teleo affective educational practices are a set of actions that are linked by understandings of these actions in particular circumstances and by rules and norms of the institutional setting about a range of purposes, projects and tasks that are acceptable ends in educating students (Schatzki, 2000). That is for William, teaching strategies and lessons are more effective when supported with skills which are part of what he called “the art of teaching”, such as knowing the backgrounds of each of his students and developing ways to assist them on a one to one basis when they need help. The importance of having this “art of teaching” reflects an important aspect of William’s vision which is to develop his students’ holistic education. In term of Peirce’s kinds of habits, William was clearly describing his habit of belief.

Throughout my research conversations with William, there was a “student” factor in almost all of his remarks. His accounts suggest his practices are influenced by his habits of belief (such as the need to have the “art of teaching”), his habits of interpretation of good teaching and learning (such as student knows when a teacher has thoroughly prepared a lesson) and his habits of action (such as the interest he shows to each individual student).

**Development of Practice and Understanding**

William recalls his own efforts to learn about teaching from a teacher from another school. He positions himself in his conversations as open and keen to learn about ideas that might improve his practice, as shown in the quote below.

> **You** learn and **you** watch other teachers. In my third year or second year of teaching I went and watched another teacher who taught at [another school] and he was absolute brilliant. He was **always** controlling the class; he was **always** in eye contact with everyone in the room. He was an experienced teacher. He started every lesson with some questions about what they'd done in the previous lesson […] and that links the lessons, so he did that, every single lesson he did that, **you know** and when he did that he kept his voice low, moved around the room, used eye contact, fist gestures [William, 2, 305]

Using pronoun grammar analysis, William’s use of “you” at first indicates his generalising of all teachers before switching to “I” to indicate his personal own experiences. The use of the qualifying word “always” indicates his effort to emphasise his point of how this teacher that he learned from was consistent with his teaching strategies in every lesson. This links to what he thinks beginning teachers should be doing. Learning from others seems to be particularly useful for William perhaps because he did
not do any practice teaching in his teaching certification course, which was for teaching at the tertiary level. Indeed, William considers that a teacher needs to be a learner too. He considers working in a team, where a common goal for all team members is to not only improve own teaching but also to support each other in improving their practice, provides teachers with significant learning opportunities. As a result, in his school, team-teaching practice is given a priority.

William’s inclination to study experimental physics in a higher degree by research after completing his undergraduate course is consistent with his views conveyed in his interviews that doing experiments in physics allows students to learn about the real world. William considers that the programme for teaching physics, developed by the Nuffield Foundation, which he learned about during a visit to the United Kingdom to study physics teaching, provided him with good understandings of some physics teaching approaches. The quote below illustrates he supported the Nuffield programme, which was based on the view that doing experiments in science and physics would encourage students to think like a scientist.

Nuffield physics was particularly good [...] They put a lot of work into devising experiments and then they also thought that it was also important to be able to think like a scientist, how science gets from one point to another [William, 3, 283]

William’s view is that learning physics is not just about learning abstract, theoretical knowledge and doing experiments to verify theory and develop measuring skills but more importantly, it is about learning to “be an experimenter”. Hence, he considers learning activities should encourage and allow students’ thinking as a scientist, by giving them opportunities to plan, design, conduct and eventually analyse and write about an experiment. This is the intent behind what is called “Extended Practical Investigation” (EPI) in the VCE physics course which he was involved in introducing.

Similar to Nelson’s views on teaching and learning physics, William clearly sees that although traditional approaches to teaching physics start by assisting students to develop an ability to solve simple problems, physics teaching should be more than this. However, unlike Nelson in his interview, William did not clearly discuss how he developed conceptual understanding in his teaching although he did indicate the importance of finding pathways to make lessons more interesting. He expressed his worry that students tend to view physics as an ability to solve problems without conceptual understanding.
He pointed to the value of teaching physics because it allows things around us to be explained clearly with physics models. William clearly possesses a personal philosophy about physics education, and in that respect is similar to Nelson’s. This is different to another two experienced teachers who will be discussed next, Kate and Noah, who in contrast displayed limited views of teaching and of physics education.

William is similar to Nelson in respect of having a big picture view of physics. As can be seen in the quote below, William portrays his views of physics versus the other sciences through his comments about the nature and underlying philosophy of physics and teaching.

Physics is always trying to find very basic rules to describe everything. It’s to look at fundamental principles. Chemistry is often happy with details and biology is still happy with details. But, physics wants to know you know, what’s the fundamental reality underlying all these [principles] [William, 2, 93]

Again similar to Nelson, William expresses views and insights about the nature and philosophy of physics that are linked with the way he teaches physics.

There’s something about physics that teaches you to think big picture. I think, what are the principles? And how do we apply the principles and make you comfortable with, uncertainties because that’s part of physics. Because physics is such a great modelling discipline, you know. So you consider the nucleus for example. We don’t really know how it works but we make models of it, you know protons and neutrons or liquid drop, or a shell model and there’s a lot of real problems in life are like that. You can’t describe it accurately but you can make a model and so it will work for a while [William, 2, 84]

PGA of the above statement provides evidence of the strength with which William represents himself as a physics teacher through his use of “I”. He then used “we” to indicate he was also representing and acknowledging himself as a member of the community of physicists. The above quote provides a strong sense of William’s personal identity as both a physics teacher and a physicist.

In the quote below, from the perspective of PGA, William’s use of “you” seems to indicate the kinds of physics understanding that all who have studied physics teachers should have.

Physics is seeing the simple concepts that underlie complex phenomena in the world. So, when you see a rainbow you just start thinking “oh that’s just a complicated something”. You actually, you look at it, and say “Yeah I understand that the light’s coming from being reflected by raindrops and make this angle I suppose, it’s darker inside and a bit of reflection going on”. So before physics occurs people just look at things like the rainbow and they just say that “the thing that happens”. You don’t have any understanding or any
patterns of the universe. Physics will always looking at stuff wondering about what simple things about the universe. [...] When you see a phenomenon you can understand and interpret it, you can carry out an experiment to test the theories, that sort of thing. That’s what physics is about, so it’s having a theoretical understanding and also being able to test theories and experiments [William, 3, 183]

As the quote above illustrates, William perceives that for learning to achieve the objectives of a lesson, teaching often requires more than the transmission of knowledge, and gives students a productive framework for their own explorations of phenomena. Importantly, he sees learning physics allows students to apply the understandings they have developed to satisfy their own curiosity and questions about how things work. He articulated his underpinning views of how physics links simple phenomena to more complex and broader problems. William reveals his understanding of physics as being concerned with identifying the basic principles that explain things that occur around us with the use of physics models. His use of the technologies of the self is illustrated by his discussion about his physics understanding and how he develops his physics teaching.

Nevertheless, William indicated that to achieve better teaching and learning, a teacher needs to be committed to spending time to prepare every lesson well.

Ever since I started teaching, the best way of managing your classroom is to prepare your lessons thoroughly. If you don't prepare your lessons, the kids know. The kids interpret it as you don't really care. If you've prepared your lessons thoroughly, at least the kids know that you're committed to it. You've got stuff to go through. You've taken the bother to go through it. If you get the work, if you mark their works and get the works back to them quickly, they know you care. If you don't bother, why should they bother? [William, 2, 393]

William showed whole-heartedness and real commitment in his work, which is evident throughout his stories and illustrated in the above quote. His indication of the importance of every lesson to be well prepared with a thorough planning is an example of his use of Foucault’s technologies of production. His stories also point to his abilities to select and use teaching ideas that other people present at professional learning sessions, and indicate his use of Foucault’s technologies of sign systems. He also discussed how he conducted his teaching practices, which illustrates his use of technologies of power. His habits of interpretation concerning how to best manage his classroom and his habits of belief on the importance of acknowledging and understanding individual students’ needs, have enabled him to show what works best for his practices. His habit of interpretation coincided with his habits of belief and has been confirmed by his experiences in his teaching.
William recognises his teaching approaches come from many years of experience. He links many times in his discussions with the aspects of the “art of teaching” as discussed earlier. He clearly considers having the art of teaching is essential for a teacher to develop throughout their career. It seems that for William, be it in physics or in any other subject, it is essential that teachers develop the art of teaching. He sees that the art of teaching includes basic things such as knowing students’ names and acknowledging individual students’ capabilities and interests, in addition to being able to develop, structure and conduct lessons that engage students and encourage them to work productively with each other. He places priority on confronting and understanding his individual students’ needs as well as in understanding the struggles faced by each of his students; a similar claim to that made by Nelson.

Aspects of his art of teaching were apparent when William took over a class from a teacher who was on leave. Prior to the lesson, he told me that because he was not familiar with each individual student, his teaching approach might be different from his usual one. In the class, I could clearly see William’s effort to learn the students’ names. As the class was concerned with continuing students’ work from their previous lesson, he indicated a good classroom management technique by beginning the lesson by writing up ten simple questions on the board related to the topic and the lesson continued from there by setting the students questions to answer from the workbook.

With his own class, in one of the practical lessons that I as a researcher observed, he permitted his students to work in teams independently, and with minimum instruction from him. The students seemed to know what they were expected to do and as a result, William was more available to talk and have discussion with individual students as needed. William regards it as being essential that he is available anytime for any of his students when it comes to physics learning. This is not only restricted to classes timetabled as seen in the quote below. Furthermore, William considers having time for individual students enables him to help his students beyond subject issues, such as with personal concerns they face outside the classroom or the school.

I have taken the bother to find out [my students’ problems] and I also made myself available on emails, and also [text] messages [via phone] [William, 4, 296]

While William makes himself available to his students through emails and by meeting with them individually at lunchtime or after school, he admitted that to be available
anytime for students would be difficult for beginning teachers as he recalled from his own experiences. He indicated that often in early years of teaching, teachers tend to have higher priorities in preparing lessons and dealing with marking.

William perceives physics teaching as not only providing accesses to knowledge for students, but also enabling them to better understand the nature of physics and the holistic purposes of learning. At the same time, in the process of teaching, William recognises that he is also learning and coming to a better understanding of physics and purposes of learning physics. As already noted, he demonstrates his recognition that both teacher and students must take active responsibility for the students’ learning process. This view seems to be a result of his many years of experience that have built up and shaped his understanding of the process of teaching and learning for him and more importantly, for his students.

The quote below portrays his views about what he called the “learning relationship” between a teacher and students which he sees as distinct from power and friendship relationships.

“I think effective teachers develop a particular kind of relationship with their students. If I was forced to describe it, I’d say, it’s a learning relationship, not a power relationship or not a friendship relationship. It’s a relationship in which the other person recognises that, maybe you have got some stuff that can help them and the teacher recognises some aspects of how student learn, […] I’m always looking and trying to decode their body language to see how much their understanding […] no teacher should have only one way of explaining something. So, I’m always thinking if something doesn’t work how else could I explain it. How else could you approach it, if the class isn’t engaged what else could we do? [William, 3, 79]

Using PGA for the above quote, William’s use of “I” indicates his own view and furthermore, his use of qualifying word “always” seems to strengthen his views. William’s account points to his sense of professional wisdom and agency as a teacher in a classroom. However, in the quote below, he switched to “you” to indicate he was expressing a view concerning understandings about practice and relationships with students that he considered all teachers should develop.

It took me a while, it takes every teacher a while to learn how to manage their classrooms and what happens is you build up a relationship with your students, that’s hard to see from the outside when you’re just walking into the classroom, the kids know what it is, you know what it is, so the first two or three years of course are hard because there was, there is a myth, you have to keep up with them all the time [William, 4, 258]
Similarly, the quote below highlights William’s above-mentioned understanding of the responsibility of both teacher and students for effective learning to take place. In the quote, he used “teacher” instead of “I” or “you” to again indicate a view that he considers is generally one that any teacher should have.

The question is who bears responsibility for learning in the room? Well the answer is both teacher and the students bear responsibility for learning but there are some teachers who say “I’ve given them the stuff and it’s their problem”. Oh that’s not good enough. You might’ve given the stuff but did they actually hear you? [William, 3, 121]

The above quote as well his many other comments show his understanding of his relationship with his students as being a learning relationship. William’s use of the technologies of power is seen when he chooses to conduct his teaching in ways that are consistent with his awareness of the importance of building on a learning relationship with his students. Thus, his habit of interpretation that learning is both the responsibility of teachers and students influences his habit of practice.

William sees the importance of getting feedback from students. He thinks it is important to also get feedback outside the learning component of teaching. Besides the standard students’ feedback on teachers provided by the school, William also asks for feedback on the affective domain, that is his students’ feelings towards their own selves and towards their teacher. Through being asked to provide feedback about their feelings, William thinks that students become more aware about their own feelings and about their own learning. William also thinks the affective feedback provides teachers with a better understanding of individual needs and preferences in learning.

Kids need to know where am I? Where am I going? And how do I get there? Any human activity would have an intention, you have to be able to measure it and work out whether you got there. Assessment for me is not a dirty word. It’s a good word, even if the assessment is involved for some kids to pick a statement about themselves. I found this to be interesting. I mean at CH school we used to have class feedback surveys, for every class at the school.[...] Well that’s a form of assessment. That’s not the only assessment and I’ve written some others, which are not to do with their learning but their feelings about themselves and the teacher and the classroom [William, 4, 242]

William’s consideration that there is value in including affective components in students’ feedback of his teaching confirms teaching is a teleoaffective practice for him. That is, he considers his teaching actions need to meet acceptable ends in educating and fulfilling the expectations of his students. He indexes the moral obligation and the “oughtness” of
teaching and learning for teachers at his school and his students being in a private school as can be seen from the two quotes below.

*You* have to find ways that work within the culture. *I’ve* been here for 31 years. *I’m* recognised by the culture as an effective teacher. *They* know if *they* listen to *me*, *they’ll* get well taught. So *I* got kind of a head start. When a new teacher comes to the school […] it’s harder for them at the start, but if *they* persist, *they* have no problem at all, they’ll get accepted […] *We*’ve got a framework [at this school]. *You* see if *the* new teacher is struggling, *they* need help very quickly. […] *I’ve* been trying to push this school to get help into the classroom quickly as soon as *you* know something is not working [William, 2, 343]

*You* got a reputation in the school like this. *It* just takes a while to establish yourself. *You* learn things that work over time. *It* depends so much on the particular students [William, 4, 274]

In regards to teacher training, William claims that his teacher training had not greatly helped him in term of providing him with skills to develop the craft of a teacher. However, he has strong views about the advantages of the current teaching model employed in a local university where he gained his teaching qualification. The current teaching model uses a clinical framework that requires teacher candidates to spend two days per week in a school from early in their studies with support throughout. He thinks this model could deliver support to teacher candidates by providing them with different experiences and actual practices in the classroom throughout the two-year programme and also prepare teachers to be reflective.

*You* need lots of different experiences from different schools and chance to make mistakes, so *I* think *you* need basically two things, *you* need lots of practice in actual classroom, *you know*, either doing this or watching or helping or something like that and *you* need to be taught or keep being taught on thinking and reflect them and the two things should interact with each other and of course *it* doesn’t finish at the end of [teaching qualification], so *you know, you* keep learning throughout your whole teaching career, and *I’ve* only taught for 36 years in schools, *I’m* still learning things [William, 4, 326]

The above quote indicates William’s long-life vision is to learn along with his students. He draws on his own experiences of developing as a teacher when voicing what he considers should be the experiences of beginning teachers today.

Similar to Nelson, and as noted earlier, William has carefully managed his development by listening to people whom he felt had powerful ideas that he could use and by only attending selected professional learning sessions that he felt would benefit his teaching. He is clearly reflective about his work and thus he sees the importance of teachers always
considering how much new ideas or knowledge that are either gained from others can be
applied in one’s own teaching.

As discussed earlier, William also perceives team teaching in schools as one of the best
ways to develop a teacher’s craft. For him, team teaching allows teachers to continuously
learn from each other. Being in a school with students who are academically good and
where student motivation is less of an issue, team teaching allows teachers to focus on
developing their skills.

Well I think they’re [conferences] fairly ineffective at changing teacher practice. They’re
just marginal. I think that, the first most important thing is [beginning teachers] should be
working in team situations within the school with experienced teachers. The sorts of
mentoring and coaching [William, 2, 193]

His remarks indicate his active and reflective thinking. He further explains that teachers
should not just attend professional learning sessions but should actively listen and think
how the new knowledge or information can be used and put into practice in their own
classroom.

Well, before I go to these sessions, I umm you have to ask other people, what they thought
of them and then you take account and you go but when you’re actually there, when I’m
listening to someone speaking on education, I’m always referencing it to how would this
affect my classroom. I’m always thinking, could I do that, could I put that into practice,
could I? So I’m not, I don’t go to these PDs with the idea of just listening to their theories.
I’m always referencing it to imagining doing it in my classroom. I don’t think everyone
listens like that. Some people just listen and write things down but I keep thinking. It’s the
change process that is very interesting [William 3, 50]

William demonstrates his practical understandings that teachers need to be selective and
reflective when learning and listening from others such as in conferences as to how to
adapt and apply the new ideas they obtain in their own practices. He demonstrates through
his use of Foucault’s technologies of the self that he is able to recognise the sign system
according to which he is supposed to operate and teach based on the type of students and
the school’s expectations. He demonstrates his use of Foucault’s technologies of power
through his observation that the ideas he gained from professional learning sessions do
not necessarily always work well for his teaching.

4.3.2 Summary of William’s Narrative

William is motivated by his vision that learning to teach is a lifelong process. He
explained his thoughts about what and how he thinks effective teaching could be
achieved. He sees teachers’ progressive growth throughout a teaching career should include development of the art of teaching through acquisition of physics disciplinary and pedagogical knowledge and skills. He considers the essential requirement for teachers to possess the “art of teaching” is to show interest in their students’ welfare, and know their names and their individual needs. It is interesting that William emphasised these skills as essential for teachers although these skills may seem obvious and common sense to any teacher. It surprised me that he repeatedly emphasised these skills at many points in his interviews, so clearly they are important to him.

William thinks that it is essential for any teacher in any discipline, to be willing to learn from his or her own experiences as well as from others. William’s reflection and views of teaching and learning are not restricted to being a physics teacher but more concerned with being a teacher in a school. His intelligibility of physics teaching with respects to the four dimensions; vision, motivation, understanding and practice reveal his inclination to prioritise being a teacher in a school. His discussion of his own teaching practices and what he thinks beginning teachers should be doing to develop their practice reveals aspects of his development as a school teacher first and foremost, and then as a physics teacher.

His thinking and thus his reflection have displayed the attitudes of responsibility, open-mindedness and whole-heartedness as a person, as in the community of his school and as well as in a community of physics teachers. William clearly displays the attitudes of what Dewey considered as the essential constituents of readiness for a person to engage in reflection (Rodgers, 2002).

4.4 Noah

4.4.1 Introduction to Noah

Noah is an experienced teacher and has been teaching for about thirty-six years. He has held some leading roles in his well-resourced boys Catholic school as well as an official role in the State-wide VCE examination assessment process in senior physics. He has taught science and mathematics. At the time of my meeting with him, he was only teaching physics. His accounts of his experiences in his early years of teaching and how his roles in his school have influenced his practices show his commitment and whole-heartedness. He was keen to discuss aspects of his school that have encouraged him to
persist with teaching; a particularly important aspect was having a good relationship with everyone in the school.

**Vision and Motivation**

Noah always wanted to be a teacher, as illustrated in the following quote.

> I was keen on being a teacher, and I knew well what I wanted to do so I kept my motivation [Noah, 2, 287]

As seen in the quote below, Noah displayed a strong personal view through his use of “I” and qualifying words “really” and “very”. His uses of these qualifying words seem to indicate his views and strengthen his stories. Indeed, Noah used qualifying words more frequently that the other teachers in this study.

> I like the whole thing. I like the teaching staff that I work with over the years, not just in science area but the whole teaching staff. The people are really, very important. I really like teaching. I really like the classroom atmosphere. I really like teaching, being in the class with the kids and you know all that sorts of stuff, [...] I think I get some sort of relationship with them [Noah, 1, 31]

His purposes as a teacher and his passion for being a teacher were in terms of how he described the importance of his relationships with his classes and others which has always been his motivation to his work. He acknowledged the school in the form of both institutional practices and social relationships that have provided him with support in his chosen role. He enacted what his right is by ensuring himself to be supported by others. He explained that he enjoys working with his colleagues. For him, feeling positive about his relationship with his students as well as with others in the school indicates how he understands his rights and duties in the school with respect to his local moral order. He indicates his knowledge and awareness of his duties to his students on the practical aspects, which includes knowing of what to do and making his class a learning environment, which is well beyond the propositional knowledge of physics. For him, it is prioritising by making his students and their parents happy. Hence, his teaching is not necessarily informs his depth knowledge of physics and/or his depth knowledge about physics teaching.

Noah’s initial commitment to being a teacher was reflected in the confidence with which he gave critical feedback to the State examination panel while still a beginning teacher.
I think in my second year of teaching and we used external exams and things periodically through the year. I probably was a bigheaded (laughed) so with some of the exams, I sent off comments to the exams setting panel of the State’s [Victorian] Physics Standing Committee … “This question is wrong because of this or all the answers you provided for this question really should be…” and I put in some, you know, just put a few comments here and there and the next year I was invited to be on the committee and that involved rewriting the courses and maybe for a young teacher who was just in second year of teaching that possibly had some sort of influence on me thinking “ohh I can be involved, I can contribute” [Noah, 2, 145]

It seems that for Noah, being part of a committee involved in curriculum writing and assessment during his early years was a significant social episode in his professional identity formation. This contrast with many of the early career teachers interviewed for this study, and discussed in the next chapter, who do not prioritise being involved beyond their immediate duties in their first school appointment. For the early career teachers, their priority is to be accepted and to feel secure in their jobs by doing what is expected of them at their own school. Using Foucault’s technologies of the self analysis, Noah showed how he is able to sign and produce his ability as a physics teacher with his involvement beyond his school’s duty and be recognised with his power to perform and submit himself in this task by the committee of physics teachers in the state.

For Noah, what makes sense to him in order to develop his agency as a new physics teacher during his early years was through his commitment and involvement with the structures of physics courses and examinations. His account of his agency is bound to teleoaffective phenomena of meeting an acceptable broader purpose in physics education, via his involvement beyond his duties in his school. For him, teaching is a satisfying and rewarding job through his contribution and commitment beyond his roles in his school. Noah’s commitment and advancement towards an aspect of his identity formation was through the means which he appropriates to the society of physics teachers. This shows his self-cultivation (Harvey, 2002); a term which Harvey refers to the works of Georg Simmel and Roy Bhaskar. That is self-cultivation is when a person is consciously producing himself for future self-production that is based on communal condition. Noah has shown his commitment by advancing appropriately and permits his technologies of the self through working with the society of physics teachers for the structure of examination and assessment of physics in the state.

Noah’s agency in non-teaching tasks, as seen in the quote below, indicates how much value he attributes, not just to individual participants, but is organised by a pool of
understandings and by a set of rules (Schatzki, 2001, p. 58). For Noah, in order for him to continue enjoying his work and be part of the school, he is active doing tasks of what a broadly defined teacher could do, which is not only limited to teaching. This practical intelligibility shows his understanding of his duties and obligations which, he recalled and discussed, had started from his contribution to the state curriculum writing and assessment in his early years of teaching to his present day.

I like what I’m doing [...] a variety, administrative things, coordinating jobs and all the little bit of variety all the way. It’s not all fun, there’s a lot of hard work but there’s an excitement in there and you build a sense of achievement and things [Noah, 1,36]

Examining the above quote, using PGA, we can see that the use of the pronoun “you” refers to a generalised “other” in his assertion of the normative structures of teaching in general. For Noah, his involvement in non-teaching tasks gives him a sense of achievement.

Development of Practice and Understanding

Noah emphasised that his passion in physics has assisted his enjoyment of teaching. Not only does he enjoy his teaching but he also enjoys his students, which seems to illustrate his sense of obligation to the rights of his students to experience physics lessons as fun and positive.

The thing that keeps me [teaching is] more than the actual subject content. It is probably just that I like the kids. I think they’re happy with me, I’m happy with them. They’re probably the most important. I love my physics but I also love the kids too and I enjoy the teaching [Noah, 2, 330]

Noah’s actions in his teaching using the physics entities appear like a “lit-up expanse on the stage of a theatre” (Schatzki, 2005, p. 469).

I’m just fascinated by the physics side of things and I try to throw in a bit of weirdness. Some of the weird things, talked a little bit of the relativity, quantum mechanics, some of the astrophysics stuff we do, try to throw in a little bit here and there, as we’re going along just to liven things up. The students won’t understand terribly well, what are the basic principles (laughed) on what’s going on but they have a little bit of a feel for the flavour of the subject and the weirdness of it and the fascination with it. I find that’s fascinating [Noah, 3, 23]

In terms of Peirce’s kinds of habits, the above comment reflects Noah’s habit of belief that it is essential to make physics lessons exciting and fascinating. Noah believes that through his physics teaching, he is able to help students gain basic insights into physical
reality and transfer to them his excitement about new discoveries. His teaching is an enactment of his own fascination with the ideas of physics, through which he can conjure the curiosity and competency (Bruner, 1960) that comprise the will to learn physics amongst his students.

In terms of physics with other science subjects, Noah’s comparison of teaching science and physics and mathematics illustrates common-place reasoning, positioning the researcher with “you know”, of the greater variety of actions that comprise science and physics teaching.

I find [maths] a bit too much the same all the time. Well I quite enjoyed it and I used to like a lot of teaching maths but I find with physics that you can do more variety of things. Like, you know, demonstration and pracs and all sort of different activities [Noah, 2, 323]

In another interview, when Noah was asked a specific question about his practical understandings of physics teaching, he elaborated his views of how physics differs from other subjects; a view that is similar to Nelson and William.

I think physics is a lot more of a big picture, understanding clear ideas and being able to apply those whereas the other sciences at a school level and tertiary level, there seems to be a lot of rote learning. I mean there are principles but that seem to be more exception for the rules and the principles. There seems to be a lot to actually just learn whereas physics it seems to me is more a matter of understanding […] I would say physics, I find at least, is more interesting because of the big picture. All like astrophysics, the weird stuff, relativity and quantum mechanics, these are all fascinating whereas chemistry is a bit more to me is a bit more mundane. […] Biology yeah that’s a bit more world around you involve with [Noah, 3, 12]

Using PGA, although his use of “I” indicates his personal view, the stories were sacred in general for many physics teachers, not only as discussed by the teachers in this study. Physics is often seen as knowledge that allows explanation of basic phenomena in the real world (Driver et al., 1994; Ogborn, 2008). These stories and understandings are seen to be what influences many teachers’ day-to-day practices, such as the view that physics provides explanations for things that occur around us by teaching with models or demonstrations may be seen as the norm of physics practice. Nevertheless, Noah’s agency is evident as he positions himself to physics education with his use of “I” which is then followed by the qualifying words “more” and “actually” to strengthen his stories.

As the above quote illustrates, although Noah pointed out a deeper understanding plays a central role in physics when compared to other subjects, he did not provide much of an explanation about how he ensures his students’ understanding in physics develops. He
does not mention the kinds of activities with which he attempts to engage and help his students appreciate different aspects of physics. Here, his habit of interpretation is intertwined with his habit of belief, that teaching should be made fascinating. These habits coincide with his habit of belief that regardless of what subject he teaches, it is for the students’ enjoyment and happiness. This explains that his agency is of less individual intentionality for himself; instead he regards rules in his practices of teaching are to enact upon his students’ rights by providing fun lessons. It was hard to identify Noah’s specific views about good physics teaching apart from his belief that his fascination of physics would get transferred to his students through his teaching.

Now if I was teaching maths, I’m teaching the kids maths. I’m teaching them physics, I’m teaching them science, I’m still teaching the kids and I supposed that’s the common aspect that I enjoyed the kids […] You need to enjoy the students really quite well with them, otherwise the jobs become too hard [Noah, 2, 335]

Noah’s repeated use of “I” indexes his strong personal and agential positioning as a teacher regardless what subject he teaches. The use of “you need”, indexes his moral or normative position of what is expected of a teacher. Again here, as can be seen in the above quotes as well as in his other quotes, Noah often used qualifying words in his descriptions.

Noah’s habit of interpretation of good teaching, similar to many of the teachers in this study, is that it resides in his good relationships with his students. As evident below, this good relationship makes physics learning interesting and enjoyable.

I think they like the classes. They enjoy it. I think it’s probably partly because of the subject and it’s partly the way I ran classes. It’s a fair bit of humour, they like that, they like jokes, they like humour here and there [Noah, 1, 10]

The role of humour in teaching, which Noah mentioned as in the above quote and throughout his conversations with me, was also discussed by one of the pre-service teachers, Simon. Simon recalled how his physics teacher from his student years used jokes and humour, and how that had influenced his view in becoming a teacher.

Noah considered that students need direction in their learning in terms of what they would do. Thus, for that reason he admitted although he wanted and tried to teach non-traditionally as evident below, he is still comfortable teaching traditionally. Noah reveals a strong sense of agency in the way he teaches. His use of technologies of power in his practices is seen by him choosing to operate and conduct to his own teaching approaches
which present his technologies of the self as a physics teacher. Furthermore, as also
discussed earlier, his habits of interpretation and belief of making students happy and be
fascinated confirmed his teaching works well for both himself and his students.

I think the kids need a little bit more direction to what was going on so it is probably has
influenced me to be a little bit more dictatorial […] so I think I was influenced to be a little
bit more traditional. I might have experienced the non-traditional way and I was very keen
on the non-traditional stuff; the individualised learning and I have even tried to set that up
in the physics area initially and I felt that everything was a bit slow. I’m a bit results-
oriented. Traditional way works well. I think so. The kids are happy. They know what’s
going on. They get good results and people will say of course you will get better result
because you teach traditional ways, and the kids are happy, the parents are happy. They
enjoy the subject. It would at times be nice if I have a bit more time to ramble on and going
to other areas and cover some more [Noah, 2, 504]

It was difficult to identify Noah’s specific views about good physics teaching even when
a further direct question was asked (i.e. how do you ensure your teaching make your
students understand conceptually?). The following response was given:

I think [my students] really, majority [of them] have quite a good understanding of the
concepts. We have a pretty big range of students and I think even the middle and weak
ones have come in a way with a fairly reasonable understanding of the concepts in physics
at this level […] I’d like to be able to interest them and motivate a bit more [Noah, 2, 521]

Not only was Noah’s response was vague, he did not indicate why he thought his students
understood the concepts. Indeed, his teaching focus seems to be on generating interest
and motivation, the assumption perhaps being that will ensure learning and understanding
to take place.

At the junior level of science teaching, where the pressure from examinations is less,
Noah considered he is less traditional in his teaching. At the junior level, he prioritises to
some extent the quality of conceptual understanding his students achieve although his
main aim of teaching seems focused on covering the subject.

[With the lower] levels, I’m thinking “let’s not worry so much about all so much contents,
let’s try enjoy a bit more, have a little bit more fun, enjoy science, come to good
understanding of fewer concepts, not trying to cover so many” […] so yes as I get older I
think it’s more important to do a bit more fun, enjoy a bit more and the kids enjoy the
subject rather than trying to teach them too many things […] I still tend to teach them too
many things (laughed) but because we have a course that leads up to Year 12, I’ve got to
change the attitudes of more people. So what we got to do is we’ll be doing this after
the change of the Australian Curriculum. I will be trying to cut down the content a little bit and
allow a little bit more open-ended investigation. A bit of variety of what we are doing
perhaps [Noah, 2, 527]
It seems that for Noah, what he does are not dictated by the “rules” of the current curriculum. It may be perhaps he has not been explicitly accountable for his stories in other discursive circles outside or inside his school. This could be perhaps of his bureaucratic, charismatic or intellectual powers in his school particularly being in a school where his physics students are known to have strong academic motivation from home.

Noah hopes that with the introduction of the new Australian National Curriculum, there will be less content to cover and a variety of activities that are consistent with current practice in the school (indexed by his use of “we”) and understanding on ways to teach physics. The new National Curriculum for Kindergarten to Year 12 is being developed to be used by schools in all states and territories of Australia. Nevertheless, each state and territories of Australia will still hold own responsibilities in terms of assessment requirements and processes. Even though Noah hoped to include more investigations in his own teaching under the new National Curriculum, and believes there will be less content to cover, his account of his current teaching practice at both the junior and senior levels prioritises coverage of requisite scientific concepts rather than the practical applications of that knowledge to its significant uses in the social and cultural aspects.

Noah recalled his early years as shown in the quote below.

I was the only physics person in the school. I spent, you know, I spent a lot of time developing resources and problem sheets and things like that myself. It didn’t really worry me, I have to say..that I was the only one there. I was the expert in the school I was quite happy with that (laughed). I think I was confident in my knowledge and understanding of physics from my university studies and from probably my education studies. I thought I knew enough about the stuff [Noah, 2, 270]

Noah’s use of “you know” indicates his expectation for beginning or young teachers to do the same; a good degree of resourceful self-reliance. He shows his understanding of being resourceful as part of his duties and responsibilities as a teacher. He talked about his commitment and confidence in his works. His indication of his confidence in his own understanding of physics which he gained from his education studies confirmed in his ability to teach. This is seen by how he felt secure and self-reliant even being as the school’s sole physics teacher during his first few years of teaching.

Noah shows his commitment and enacted his duty to other teachers by supporting a mentoring programme for new teachers in his school; an initiative which aims to provide teaching resources, and update teachers’ subject content knowledge and teaching
techniques. He sees support for teachers is important for their continuous development, although he did not discuss what kind of support he received in his early years of teaching.

I think an important part of physics teaching is particularly for the experienced teachers to mentor new teachers coming in the school. In physics, we’ve a few new teachers here over the years and I’ve been able to encourage them along and supply them with [teaching] materials and I met them one to one for, you know, a couple of hours before we start the first topic and then I’ll give them all the materials, the notes, the PowerPoint, the booklet, the problem sheet, all these sort of stuff and actually go through explaining what we do or what I do. They don’t have to do exactly the same. Oh well, we tend to do the same practical for the students but demonstrations are things that people vary [Noah, 3, 55]

Similar to many teachers in this study, Noah felt his teacher training had not prepared him with knowledge of management skills. He recalled the difficulties that he faced in his early years of teaching as evident in the quote below.

I think my teacher training didn’t prepare me terribly well for students management side of things and you know preparing for the course materials and things like that was not too bad but there wasn’t really much done on the students management side on how to manage classes, how to manage difficult students, how to organise things. I think, well you just pick it up as you go along. You learn, you teach yourself [these] things and I think while teachers vary a lot in their approaches to things, so they are going to learn what's best for them as they go through in the first few years but I still think it would be valuable for beginning teachers to be given some techniques of what you’re going through, what you’re going to probably come across some sort of situations and here in some ways of dealing with it [Noah, 2, 163]

Perhaps, because of his own experience during his early years of teaching, which he faced while having difficulties in management skills, Noah is now currently active in providing new teachers in his school with mentoring and support. In particular, he offers help with teaching resources and developing subject content knowledge.

4.4.2 Summary of Noah’s Narrative

Noah’s discussion and description of his teaching practices reveal aspects of the development of his identity as a physics teacher, and of his intelligibility of physics teaching, in terms of vision, motivation, practice and understanding. He is not as reflective as Nelson and William in terms of what informs his teaching and classroom actions. He voices his stories by recalling his memories of his early development and practice. His views are emphasised with his habit of belief to be passionate and committed in his works. This is clearly seen in his habit of daily actions such as providing mentoring and involvement in non-teaching tasks.
Noah’s stories are more about his general views of how to be a teacher. Although Noah is not as reflective as compared to Nelson and William in relation to his students’ development and learning of physics, his accounts displayed his attitudes of responsibility in the community of his school and in a community of physics teachers. This is particularly in terms of his commitment to provide mentoring for teachers in his school. His significant role in the VCE assessment process indicates his credibility as a physics teacher as well as his teaching journey exciting and motivating for him. The honour and status afforded by his membership in the State Physics Committee as well as his leading roles powerfully confirmed his place in the expressive order of physics and science teaching in the school and beyond. It seems that Noah’s belief in his own knowledge and understanding of physics forms a basis for his success as a physics teacher both in classroom practices as well as with his other tasks.

Although Noah displays his passion and commitment to teaching, and tried not to be traditional, as illustrated both in his accounts and from the classroom observations, there were points which indicated at times he was result-driven. His teaching rests with his success in communicating the excitement he has found in the major insights of physics to his students. Unlike Nelson and William, it is not easy to identify his use of technologies of the self and habits but yet, the coincidence of his habit of interpretation and habit of belief of making physics lessons as fun and interesting confirmed that there was no strong reason for him to go beyond reference to the examination success of his students.

Noah views his physics teaching as helping to equip students with knowledge to be able to explain things happening around them. However, there is no clear indication to clarify if he was actually referencing this to equip his students’ understanding for the real world or to equip for examinations. His account does not particularly address knowledge or skills he has attained as those required of physics teaching and he does not describe student learning, or any other difficulties associated with physics teaching that had challenged his habit of belief embedded in his practices. His socially meaningful engagement and interaction with students showed minimum emphasis on caring about an individual student’s needs. Perhaps, being in an academic school, which is well-resourced and the students are academically motivated, this is not a concern for him. Unlike the other experienced teachers and even with some of the early career teachers, Noah did not
give specific reference or example to his students or specific events when he described about his practices.

Noah’s account can also be applied with his use of Foucault’s technologies of the self as to how he adjusts to the moral and social order of his actions. His attention to his “traditional” teaching as productive in terms of good examination results is combined with the social signing of enjoyment and meaning to his students and their families. His sense of his professional wisdom and the authority of his way of working as a teacher in his school and as a physics teacher to his colleagues and students illustrate his signing of status, honour and power.

4.5 Kate

4.5.1 Introduction to Kate

Kate is an experienced teacher of about thirty years and gained her undergraduate degree in physics and diploma in education in another country. In her career, she has taught mathematics, English as second language, science Year 7 and physics Year 11 and 12. She has significant experience working as a member of a professional support group for physics teaching and learning in the state. In her previous school, which she considered to be a low achieving school, she was involved in an action research that aimed to improve students’ participation in studying physics. Since then, she is committed to promoting physics to junior students as an interesting subject by conducting physics activities outside the classroom. She has been a head of science at her current school, which is a state school with selective entry of students and an accelerated learning programme for gifted students. She regards the school as a good school to work in because the staff and students have positive attitudes in learning.

Vision and Motivation

Kate did not explicitly discuss her personal vision or account for her commitment to physics teaching other than her concerns about the general decline in the number of students doing physics in Victoria when compared to other subjects. This has been much discussed and publicly reported in the discursive circles of the Australian Institute of Physics.
I’m very interested in making sure physics continues on as a viable study subject in Victoria. I have real worry about where physics is going within the state [Kate, 1, 6]

Using PGA, the singular personal pronoun “I”, with intensifying references “very” and “really” illustrates her sense of agency as an experienced teacher of her concerns about declining students’ enrolments in physics.

I’m worried about physics education in Victoria because it’s declining; the numbers of students taking it. Biology is seen as being the interesting science; chemistry is seen as the science that you need to get into anything at university that has prerequisites for science. Psychology in Victoria is really big, girls especially love to do psychology. So in terms of even attracting boys, physics numbers have reduced, in your choice of doing Physical Education (PE) or physics, boys are going to choose PE because they see it as sport, fun whereas physics is page 56 question 1 to 5, so I have a real problem with the direction it’s going [Kate, 2, 198]

Kate frequently talked about the differences between girls and boys learning physics. She felt that physics was neither naturally interesting for most girls nor for those boys who are inclined to do physical education rather than physics. She attempted to change this perception through her teaching by finding different ways to develop her students’ understanding.

Quite a lot of times, I have a problem with the simplicity with girls especially because physics they see as a difficult subject so they put up barriers for themselves and they don’t understand and you have to pick away at those barriers. You have to explain different ways because you know, if the front side doesn’t work, then you go around the side and you use different models and different ways of trying to explain and quite often other students would come in as well and try and assist with the understanding [Kate, 4, 390]

As seen in the quote below, Kate is clear about her initial motivation for becoming a teacher is related to the affordances provided to her at that time as a mother with young children.

I wouldn’t see myself doing this [teaching] in 15 to 20 years ago, because I was only going to do it while it matches the time for my kids on the holidays, so I did the teaching while the kids were at schools, I was going to leave because I want to get into medical physics cause that is the area of my expertise cause that’s the area of enjoyment, but […] I was actually enjoying teaching teenagers […] I don’t regret doing it, I know there is no career path within teaching but I can see it fulfilling a need you know, you sort of have not only earning money but also getting something back from your job. The previous job that I was at LD school, I did not enjoy teaching there which was when I came here that I did enjoy teaching which is why I am still teaching [Kate, 3, 276]

As seen in the above quote, having found that she enjoys teaching teenagers, Kate continues to be a teacher. My on-going conversations with Kate have elaborated her general understanding of teaching, which appears to be incorporated within teleoffective
structures. Unlike her previous school, teaching in her current selective entry accelerated learning school has strongly influenced her continuous commitment to be a teacher. The school also seems to provide a notion of teaching as a “form of life” as a result of having a supportive community with socially similar intentions and goals shared by staff, students and parents. This has provided her with a fulfilling feeling in her teaching.

In general, Kate’s accounts of her teaching were more descriptive of her vision and concerns about the problems and issues in physics education for which she could not be held personally responsible. Rather than providing an account of the authority of her experience arising from her explorations of her own teaching practices in which she has been engaged to advance her students’ learning, her stories and her positioning suggest that her practices were settled by outside factors. The outside factors were particularly related to the way the external examinations were set up and the assessment of students’ answers.

Being in a “typical” outer suburban state high school, it is expected that not all of her students go on to university; some go on to other tertiary study, such as the vocational sector known as Technical and Further Education (TAFE). Although she positioned her physics teaching as being influenced by the ways students are examined, her teaching was not focused on maximising their examination scores but rather on giving them access to the next level of their studies, through fun and interesting lessons. She explained her responsibilities as a teacher were to build understanding from the students’ engagement with physical phenomena in the outside world.

The Nerf gun [a toy which fires polystyrene ‘bullets’] outside, the rockets outside, they associate physics with being fun, the kids around here can see them, you know [...] How can physics be hard if you’re playing with a Nerf gun? So if you get it, so that even if they’re very poor at answering exam questions, they have done enough so that you can give them an ‘S’, they’ve passed and that’s good enough to get them into TAFE [Kate, 4, 236]

Kate elaborated her concerns over things related to the bureaucracy of the Victorian education system; the kinds of assessment, marking system, school resources and the National Curriculum being developed at that time. She recalled her frustrations with the examination system when she stated,

When I started out in Victoria, I had a real problem with the exams. I still have a real problem with the exam. The quality of the exams has improved but the quality of marking
has gone down and I’m having fights with the government, the [Victorian Curriculum Assessment Authority] VCAA, over the way they mark things [Kate, 2, 204]

Her later remarks relate to the mismatch that she sees between how the course handbook describes the course and what is examined. For her, the examination questions are inclined to focus on “boys” type of questions and she feels she has to likewise focus on these in her teaching in order to ensure the girl students develop the ability to answer in the way expected by the examiners. She expressed her frustration at the limited choices she was left with as a teacher to prepare her students to pass their examinations. She considers these external problems in a way affect her teaching. That is she positions herself as being subject to the authority of the examination which limits her choice of teaching approaches and hence, in her use of technologies of power.

Development of Practice and Understanding

Kate, similar to all the other experienced teachers, pointed out her pre-service teacher training course did not prepare her to be in a real classroom.

Teacher training did nothing for me at all. I did my degree and one year of teacher training. We made it interesting because we were all older students [...] We chose to change the course so we did bits and pieces which were of our interest to us which was useful to us, it wasn’t provided by the college [Kate, 2, 277]

As the above quote demonstrates, it appears that as a mature age pre-service teacher, she entered teaching with developed habits of agency. This is the case with the other mature entrant teachers in this study where their previous working experiences helped them to be able to decide and do things accordingly. For example, Kate recalled in her teacher training course, she and her course mates did change things to make the course more interesting. Perhaps, similar to Noah, this reflection of her teacher training made Kate also discussed the need to support physics teachers during their induction years as can be seen in the quote below.

I think [beginning physics teachers] need a lot of support because, teaching, when you go in, you are trained as a physics teacher. Then you get send to a school and I found teaching as some sort of other things. There is nothing to do with physics and [the school] give teachers all sorts of strange and bizarre classes and I think “I am a physics teacher, why am I supervising a soccer match? You sort of have got plenty of PE teachers that can do that and why am I being wasted?” Then you find in most schools, most of the physics teachers are the only physics teacher and so in the first year they need support and they need comfort [...] We used to have a network where the physics teachers met and you could talk to other physics teachers to get ideas but that doesn’t happen anymore [...] so you need the support
of other teachers around so that you can feel that you are not wasting your time. [Kate, 3, 372]

In the above quote, Kate emphasises the importance of providing support to new teachers in school either from within the school or having a support network for physics teachers. Kate recalled her teaching experience in her previous school as seen in the quote below had been stale and not exciting. This is an important implication for teacher educators when preparing student teachers, to realise that new teachers need ongoing and continuous support; in particular when teachers are in schools with no or minimum support, feeling vulnerable and isolated.

The previous job that I was at LD school, I did not enjoy teaching there which was when I came here that I did enjoy teaching which is why I am still teaching [Kate, 3, 283]

All the other experienced teachers in this study made similar observations about the particular needs of physics teachers. Physics teachers may not simply need support to adjust to the demands of a teacher’s life in a large social organisation, but also in relation to being isolated in their school or from other physics graduates. Nelson, as discussed earlier, also showed his disappointment with the physics teachers’ network which is not as active as when it was introduced.

Although Kate did not enjoy her teaching in her first school, she recalled that it was her first year in what she considered as a bad and difficult school that had greatly influenced her practices. She recalled her students were not interested in learning which motivated her to try and make the learning as positive an experience as possible for them. Kate’s students were clearly not attracted to science probably because the science curriculum traditionally appeared to be designed principally to train young people for further academic study in specialist scientific disciplines (Tytler, 2007).

So first thing to do is to basically get [students’] trust, get their confidence, make them realise that you weren’t going to fail them just because they’re dumb because they see themselves as not being successful but in your class, you make it so that they are successful, you make it so that their experience in your class is positive [Kate, 4, 302]

Interestingly Kate did not use “I” and “my students”, instead she used “you” which can indexes her views of the appropriate and normal teaching practices in socially disadvantaged settings. Kate set out to adapt the education system to suit her students. In her previous school, she was involved in a piece of action research that found increased enrolment of students in studying physics when physics activities were conducted outside
the classroom. This environmental variation also allowed students to be aware of physics as an interesting subject. For her, the outside activities allowed students to use everyday toys, which then enabled them to attract other students, in particular, the junior levels to see the fun part of physics. This she hoped would make students choose to do physics at a senior level. She further argued that by doing more physical activities, the students found it easier to remember and apply that knowledge to other experiences in the real world. This is an example of how her habit of belief that physics should be made interesting by taking students to do physics activities outside of the classroom influenced, and still influences, her actions as a physics teacher.

Kate did not elaborate in our conversations on any teaching and learning theories that may underpin her practices but while admiring the work of other physics teachers she heard at conferences, she generally found their views repetitive or dated. I go to the Physics Teacher Conference and I think the ideas are stale there [and] old. I can teach the majority of the things there, I can teach better than that. There are some people there who I really respect. They’ve got really good ideas, I know their ideas, I’ve been to the lectures before [Kate, 2, 284]

Kate admitted that she seeks new ideas she can use in her own teaching from professional conferences. Her use of qualifying words “really” in the above quote, “actually”, “more” and “extremely” in the quote below, strengthens her views about attending only selective professional learning sessions.

I think teaching is actually more creative and the STAVCON [Science Teachers’ Association of Victoria Conference] for instance I find it’s extremely useful. I find the regular STAVCON is more useful than the physics one. […] I think by going to the STAVCON, you see biology teachers, you see chemistry teachers, you see IT teachers and they have different ideas and you think “oh yes I can take that idea” […] so I found that much more useful because it’s much more creative and I see other people’s ideas and how you can modify them from what they are doing to what you want it to be [Kate, 2, 282]

Although Kate talked about gaining new “ideas” from conferences, what she seemed to mean was new “activities”. She did not show her open-mindedness to take into account of what others were doing or thinking. For example, she felt attending professional development sessions in her school that were not clearly related to her teaching in Year 11 or even to her students was wasting her time. This shows her attitudes seem to be rigid which limits her development as a teacher and results in a fixed view of teaching. However, at the same time she displayed her agency and identity as a physics teacher.
Her technologies of the self can be seen by her displaying her enjoyment and good feeling with what she does as a physics teacher in her school.

Kate seems to assume every teacher in her school shares the same general understandings about what holds the organisation of teaching together. She explained it is because the teachers in the school support each other. However, it is unclear how she thinks that these shared understandings operate. She spoke of her work in her current school as easy. The school environment was positive, not only because of the positive attitude of the staff but also that of the students and the parents. These shared positive attitudes of the teachers and of the students shape the organisation of the school she is working which then have strongly influenced her personal satisfaction of being in the school. Thus, even with the tension Kate still feels about the education system, she indicated she felt she was able to teach in the ways she wants.

Using Foucault’s technologies of the self, she is able to produce and sign her practices even with the lack of teaching resources in her current school. She feels that her teaching is well delivered and appreciated by her students. Her students are happy with her teaching techniques, which were regarded as exotic in her previous school and she feels respected in this important sense. The external expectation by the public of her current school that it produces “good results” was the reason why the students chose to go to that school. The students do not complain about the lack of resources that she feels acutely. Her habit of belief that she has positive school support provides her with a sense of satisfaction even though she does not have enough teaching resources. Her technologies of the self derived from that habit of belief.

On the topic of unavailability of equipment in her school, Kate indicated she often had to use online resources. In one of Kate’s classes that I went to, she was introducing the topic “photoelectricity” for the first time. Her approach was traditional in the sense that she wrote notes on the board and made her students copy them. Later, in our conversation, she explained her follow-up teaching in order to find out what her students are learning:

This time I’ve done it as a lot of information in one go and I will come back to it and come back to it again so that I’ve introduced the idea of the two different types of brass. I’ve introduced the concept of what the photoelectric effect is. It’s Friday afternoon most of it would have gone voom, right over the tops of their heads, of the kids. I’ll get the animation set working properly on Monday and show them again. I will show them clips from
Kate reflexively discussed a possible strategy and tactics regarding the topic. Her comments concerning the sequences and the activities appropriate to the timing of the lessons and her students’ capabilities revealed her pedagogical knowledge about how her students learn best. However, she did not identify specifically the resources she would have liked to have used or how she planned to use them apart from indicating her plan to make students do activities outside the classroom. The type of activities were probably like those described at some length in the action research project she was involved at her previous school; which explored activities conducted outside classroom to promote physics as an interesting and not a difficult subject.

I don’t care how stupid the student is or how smart the student is, I feel that if you do the [practical] work, for [students] who are not comfortable with the theory, the best way for them is to be involved in the [practical] work, you can then relate to [the theories] [Kate, 2, 167]

Some of her stories suggested her approaches were consistent with constructivist teaching such as focusing on and encouraging students to discuss their ideas. However, as seen in the quote below, her use of “you” seems to display her views about what teachers do or should do rather than her own actions as a physics teacher.

It’s experiences working with kids and asking them as well. You don’t just explain to them, to the kids something. You ask the kids to explain to you because it’s reverse engineering because then you can quite often see what their problem is with the understanding. They have a mistake in their understanding somewhere or there are some other problems and it’s funny because when the kids finally get the idea, they want to share it with other people because it’s suddenly so clear to them and they can’t understand why they didn’t see it before [Kate, 4, 398]

In general, Kate discussed ideas and activities in her teaching and learning physics. She explained her ideas of using analogies in her teaching, which her students can relate to the concepts as can be seen in the two quotes below. She gave many examples of physics teaching scenarios, which should be familiar to most physics teachers. As demonstrated in the following quote, she frequently displayed her commitment to engaging her students both affectively as well as cognitively.

My electrons have faces, they have legs and they run. With the year 7, they have little ninja, scarves on, they’re ninja electrons, you know, sort of zapped by bolts of lightning. You put it as a cartoon face. The kids can then relate to that, so that in the year 11 and 12 physics when you have little electrons lying on the piece of metal and they are asleep and
they are snoring, the kids can relate to that. It’s not threatening. They can understand that, they can understand the concept [Kate, 4, 209]

It is often surprising the emphasis that she gave to affective aspect of her teaching. For example, Kate said

If you’re talking about energy spreading out, the sound wave, I give them bubble-gum to chew on and they make bubbles and you then say “okay, this amount of bubble-gum is the amount of energy, the bigger the bubble the thinner the wall of the bubble-gum. That’s the same as sound, you have this amount of sound energy as it spreads out it gets thinner [Kate, 4, 270]

Kate’s teaching clearly showed her commitment to engage her students and focus on making physics less threatening to her students. For her, to achieve student’s understanding of the examinable concepts was not her main priority although, as noted earlier, she feels she needs to ensure her students, particularly the girls, are able to write answers in the ways the examiners expect of them. Her broader purpose in her physics teaching is to do enjoyable things with her students, and as part of the process her students are actually learning. Although, it is unclear how her practical understandings operate, it does seem that her physics teaching is determined by her commitment to promote students’ learning. This clearly shows her enacting on her duties to her students.

Kate’s habit of belief for her organisation of practices is co-contextual. That is her practices are determined by the social environment within the school, as well as the broader school community. Her practice is also affected by contextual artefacts such as the background of her students, the kind of examination questions her students are required to face and the teaching resources available. Unlike the many other teachers, her practices are seen to be shaped by her students collectively rather than by individual students’ needs. All these aspects of her understandings and her habits of interpretation of what physics teaching should be are brought to bear in the practices she employs to achieve better students’ learning experiences. She believes through her practical activities, students are more likely to be able to develop the knowledge at some point in the future when they will be able to explain their understanding to other students. She referred her students in the quote below as “you”:

So there’s no sense of pressure on you that you have to finish it within the time […] so with students with very poor understanding of what’s going on, by repeating what you do in the prac work, in the worksheets, and then on the revision for the exam and then the exam, they do it so many times, they come across it so many times from different areas that it eventually gets to the point that I’ve seen students that think that they’re very bad at
physics and don't understand, turning around then explaining to other students [...] So some students get the ideas very quickly and they perhaps don't need [the practical] but other students find it more comforting to actually be able to do [the practical] and then do all the reinforcing that goes with it [Kate, 2, 181]

The following quote is when Kate emphasised the importance of doing practical activities. Her integrated laboratory practices involve “hands on” as well as “minds on” work (Berry, Mulhall, Gunstone, & Loughran, 1999). She does not only focus on making sure her students to actually do the activities but more importantly that they discuss about the activities to each other which she hopes would trigger their thinking and “minds on”.

I found with practical work is very time consuming, that is why lots of school cut it out cause it takes a lot of time to do to set up and then you get the results and then you sort of analyse what the results are, but I think it is very valuable because you can then refer back to the prac that they have done and because the students are talking to each other, it also imprint in their brains what they actually done more easily than the written question [Kate, 3, 228]

Kate’s point about practical work as time consuming is similar to Noah’s view about the time involved. Noah indicated that in his school, the Extended Practical Investigation (EPI) was done as a one-day exercise with their students rather than being an on-going activity throughout school year, as was the practice at most schools. In addition, Kate’s point about the need to do practical work in physics was similar with other teachers. John, one of the early career teachers in this study described practical work in physics as a way to give physical experiences which supplement his students’ learning and that help to create fun and enjoyment in learning even if not required by the prescribed course content.

Kate viewed learning as taking place when students are able to use the knowledge for what they wanted to do next. Her teaching is an affordance that is accepted within the school environment. She also thinks that students’ attitudes to learning play a role in the process of teaching and learning physics as seen in the quote below.

Physics teaching involves many things but the most important thing is the students and the next important thing is the teachers [...] I think a good physics teacher is flexible to the kind of students that you get, what the aims are of the students, not just the skills and knowledge but their attitudes, the experiences that they get from teaching, the learning of physics will determine what they intend to do with it but not just that student but also colour the attitudes of other students around them [Kate, 1, 28]

Clearly, her practices are influenced by her habit of belief (such as how the structure of examination questions that are more towards boy-oriented, affected her teaching to her girl students and having positive school support making her teaching easy), her habit of
interpretation of good teaching (such as when students are actively engaged) and her habit of action (such as to providing what she considers to be positive learning experiences for her students and doing activities outside the classroom to promote students’ better engagement).

### 4.5.2 Summary of Kate’s Narrative

Overall, Kate’s account of her teaching focuses on her own way of teaching which suits both her and her students. However, she feels frustrated that her teaching is also affected by the education system of the state in which she teaches. Indeed, her vision about teaching links to what she sees as the failure of university’s teacher education courses and of the examination bureaucracy. Her perceptions of her restriction due to the external factors seem to indicate and link to how she understands teaching is. For her, learning happens by making activities fun.

Her physics teaching is designed to make physics as a popular subject of choice within her school. The intelligibility of her physics teaching to her encompasses the acceptable intentions and actions of a physics teacher. Her accounts of her physics teaching were strongly emphasised, both affectively and cognitively, as seen through her commitment and whole-heartedness to doing physics activities outside the classroom. She shows her commitment and whole-heartedness in physics in particularly by trying to ensure physics is seen as a fun and interesting subject to everyone in her school. This is why she likes to conduct her physics activities with her students outside the classroom.

Her habit of belief about good physics teaching did not reside in the disciplinary history and philosophy of physics. Perhaps, this knowledge plays little or no role in her everyday physics teaching practice. Her habits of interpretation and belief about good teaching seems to be influenced more by the institutional and public domains rather than addressing her individual students’ learning. That is Kate is more reflective concerning her hopes that physics is considered to be a subject taken by many students in her school than she is about her responsibility to her individual students in her own classroom.

### 4.6 Concluding Remarks of Experienced Teachers

The school context clearly exerts an influence on how and what these teachers discussed with me. For William, who works at a private school, there is a minimum discussion on
the aspects of his teaching strategies but instead more about common sense things such as learning his students’ names and their individual needs. Perhaps, his effort to motivate his students to study physics is not as demanding as other teachers like Nelson. This is because William’s students have chosen to be in the school and do physics because the students have clear visions of their future studies which will involve physics. Similarly, Kate considered her physics teaching is made easy because most of her students chose to do physics for their future studies. On the other hand for Nelson, being in a school where some students are still unsure of why they are in the school, they need an aspiration in order to learn physics. This is clearly seen many times emphasised in Nelson’s discussion on the importance of having a conversation with his students about why they are learning and doing physics. For Noah, he did not talk about his teaching or his students as an issue in terms of getting his students to actively engage or the need for them to understand what physics is. Again, perhaps being in a private and all boys’ school, Noah did not have to face students’ problems that were anything like those Nelson had to handle.

All the experienced teachers clearly showed awareness and knowledge of what to do in particular situations, which is well beyond the propositional knowledge of physics. However, in terms of their views or habits of belief about what is good physics teaching, Noah, unlike Nelson and William, did not explain in terms of a fidelity to a disciplinary principle of physics even though they are all graduates from the same university. This seems to be the same case with Kate where the unique history and philosophy of physics were not mentioned in their discussion. Perhaps, this aspect plays little or no role in the way their agencies are embodied or embedded in their everyday physics teaching practices.
Chapter 5  Findings of the Early Career and Pre-Service Teachers

5.1 Introduction to Data and Analysis

This chapter reports on the analysis of the storylines of four early career teachers and two pre-service teachers. The pattern of presenting the results is similar in structure to the previous findings chapter on experienced teachers. Each teacher was introduced briefly in relation to his or her school and qualification backgrounds. The four dimensions of teacher’s reflection (Shulman & Shulman, 2004): vision, motivation, understanding and practice were used to present the teachers’ stories. The pronoun grammar analysis (Mühlhäusler & Harré, 1990b; Redman & Fawns, 2010) was used throughout to locate the teachers’ storylines and positioning (Davies & Harré, 1990; van Langenhøve & Harré, 1999) within the teachers’ habits of description, in relation to the norms of physics teaching practices in their schools.

Foucault’s technologies of the self (Burkitt, 2002; Foucault, 1988) and the four types of habits based on Peirce (Heiskala, 2011) were also adapted in an effort to better understand the teachers through their accounts. The four habits are: habit of interpretation, habit of belief, habit of action and habit of true belief. As discussed previously in section 3.3.2 and 4.1, the habit of true belief and the habit of belief are often intertwined; these two categories of belief were collapsed in the analysis of the data and are identified as habit of belief. Identifying the different kinds of habits has provided a better understanding of the teachers’ sense of self.

5.2 John

5.2.1 Introduction to John

John is one of the four early-career teachers in this study. He was a mature-age entrant into teacher education and has teen-age children of his own. He displayed himself as a family man because his work stories often related to his commitment and his time with his family. John said he chose to participate in this research because it was a way for him to be connected with the outside school world. The reflection process which involves discussing about his work he felt could also help make him a better teacher and do his job better.
Since he gained a graduate teaching qualification about six years ago, he has been teaching in the same LH state school. He has not held any administrative roles in the intervening four years except as a football coach and assisting fellow colleagues in the use of technology. Before becoming a teacher, John had worked in information technology consultancy for about 20 years. John taught business management, mathematics and general science and started teaching Year 11 physics after four years into teaching and currently continue to teach all these subjects including Year 12 physics.

**Vision and Motivation**

The elements that John has presented as creating his vision and motivation are the ones that he perceives are part of his lived world.

> I like being with young people and seeing how they learn and it’s a tremendously rewarding career, you know, not financially, but rewarding in terms of what you get out of it, from kids [...] So teaching for me is about teaching. It’s not about the income or the career [John, 2, 241]

In the above quote, John presents his point of view for what is his intrinsic motivation for being a teacher. He utilises the pronoun “I” and “me”, indicating his personal view. John displayed his love of teaching saying that it provides him working with enjoyment. Teaching is for him a teleoffective practice, that is it is satisfying in itself.

For John, as for many of the teachers interviewed in this study, teaching is first and foremost about being a member in a school community. This has arisen from the data as the main reason provided by the teachers in this study, how important and valued being a member of a community is to an individual teacher. The designs of his teaching actions are “normative” with his use of “you know” rather than presenting his thought as an individual as seen in the quote below.

> I’m not just spending time making my physics class perfect but I am spending a bunch of time making sure that you know the school is a better place both for the teachers and for the students [John, 1, 287]

John’s understanding of his teaching practices seems to be established through his enactments to make his teaching as intelligible by working on beliefs, goals or values that are shared among others within his school community. These shared understandings, values and goals that John experiences as a physics teacher, in his school practice, seem to inform his practices and hence his habits of action.
I don’t think it’s just about having great classes; it’s about having a good school experience [John, 1, 309]

In the quote above, “it” refers to what John believes as the purpose of teaching and education for students. His school was discussed in relation to the need to have a positive and supportive environment for both the students and the teachers. The quote below emphasised, with his use of the qualifying word “really”, his point about how the good school culture enables him to enjoy his work.

I really like the culture of the school. It’s a very open, good relationship that the teachers have with the students and I like the teachers. They’re very passionate. The school has a good reputation and it does a good job. It attracts good kids so you know there was a lot to like about this school [John, 1, 41]

Having a good school culture was consistently mentioned by the teachers in this study as an important factor for their development and sense of belonging. This is an important finding in this study as a sense of belonging helps in shaping the teachers’ agency and identity.

John’s development and his identity formation as a teacher was through the means of him working actively in the society of his school. This shows his self-cultivation (Harvey, 2002), where he is consciously using opportunities of being in a good school community to produce himself as a better teacher. His technologies of the self are working and helping any teachers in his school. His technologies of production and signing could be seen through his non-teaching engagements as seen in the quote below.

I do other things. I coach a football team. I manage my son’s cricket team. I take my kids to music, so life can get a little busy at the moment and I sometimes think, “Gee if I had more time, I would love to spend, you know, teaching, improving my teaching”[…] I’m not going to reduce my time and teach poorly. I want to teach well so the logical thing to do is just reduce the number of subjects that I teach [John, 2, 221]

John explained about his non-curricular engagements in relation to non-teaching tasks. These non-teaching commitments seemed to have increased his enjoyment of the teaching profession. As evident in the quote above, for John, there is a reciprocal binding commitment between him and his school community.

In John’s account of his family responsibilities outside, and coaching responsibilities inside the school, that compete with the self-improvement of his craft skills in physics teaching, a sense of the illocutionary force on his responsibilities can be seen between his commitment in and outside his school (van Langenhove & Harré, 1999).
John indicated as seen in the quote below that his involvement in the school is not for the purpose of him being appointed or promoted and entitled him as a leader but his commitment through his volunteering in order to help others in the school.

The role that I’m [acting in] at the moment with [information] technology was advertised as a leading teacher role. We didn’t get anyone to fill it so I put up my hand and said “I’ll do it”. But I don’t want to be a leading teacher. So I’m doing the job but I don’t want the money. I don’t want the title [laughed]. I just want technology used better in the school, to improve teachers, the way that we teach. I’m happy to do that but I don’t want the overheads from the meetings and the time away from students and teaching that might come with that [John, 2, 265]

In the quote above, John explained how he did not want to be formally recognised as a leading teacher in the use of technology although he is actually doing the job expected from a leading teacher. Unlike Noah, the experienced teacher who discussed his early voluntary commitment to the State examination panel, John appears to not have been positioned himself or been positioned in relation to bureaucratic power. John said he has tried to steer clear of the school management hierarchy of the school because of the required responsibility and the authority that comes with a leading teacher position or role. Even though, as he reflects, he has not negotiated such career moves, he claims his experiences and skilled knowledge, in the use of the communication technologies in teaching, are important for both the development of teachers and the school.

John’s storyline about his contribution to the communication technology evokes his sense of strong agency as well as construction of a personal identity as a teacher in his school. Hence, he did not specifically see himself as a physics teacher and only discussed his physics teaching when prompted. Perhaps, as a result of teaching four different subjects, his motivation in teaching, as illuminated in his stories displaying his agency in his school, is concerned with being a good teacher in the use of technology rather than only focussing on being a good physics teacher.

Development of Practice and Understanding

John looks back on his early years in teaching and remembers them as being challenging. He recalls feeling stressed about institutional expectations and being busy all the time. This is something that he now feels was two of the things he had to learn to adapt to in teaching.
You always reflect back and think “I haven’t done enough” you know and you can always do more but it’s this continual conflict between, you know, the administration sides of getting reports, getting marking done, getting the latest assessment task out the door, and doing sort of the boring and the mundane part of the job which pulls your time and doesn’t enable you to do the things that you like [John, 1, 104]

At the intersection of social necessities within his school and his own purposes in his teaching, John describes his struggle to construct rules of proper behaviour. Evident is his use of the generalised other, “you”, he felt duty bound to focus on “urgent” tasks rather than doing tasks he recognised as “important” to his own identity formation as an effective teacher. He spent a lot of time marking his students’ class work, finding resources for the next lesson or setting up practical work and regretting that the lack of time that was never available to work with individual students who needed his assistance and attention. John’s use of “you” indexes his expressive disengagement from the testing and correcting processes, which committed him to the routines expected of a teacher. This seems to restrict his opportunity to have extra time to focus on or try different teaching approaches in his classes such as having more outdoor classroom activities.

John understands that textbooks offer an easier option and a quicker way to prepare lesson plans and cover topics, especially for someone like himself who is struggling to manage his time. However, he recognised that such a practice was at odds with his habit of belief that good teaching should go beyond the use of textbooks. Furthermore, his use of “you”, as seen in the quote below also seems to indicate his habit of interpretation that any teacher should always strive to be a better one.

You can’t always just turn to the textbook and do problems and that’s a hard balance to strike because, you know you can always do better [John, 1, 111]

Under pressure to manage his time while teaching in four different subjects, he indicates that time management is a problem that he has not yet fully overcome.

I constantly umm I walked out of a lesson and think to myself “That was a crap lesson” you know, and I know it was crap because I didn’t put the time in and I didn’t, you know, I didn’t engage the students, I was underprepared and that’s a very frustrating situation being in but it’s hard [John, 1, 144]

John positions himself as dissatisfied with the quality of his teaching which he attributes to his lack of lesson preparation time in the face of his commitment and desire to improve his teaching. This seems to be his challenge since becoming a teacher; being busy all the time.
John does not index in his conversations a collectively constituted meaning through the use of the collective pronoun “we”. His repeated use of “I” indexes his strong positioning of his own inability to provide the best that he could. John’s use of technologies of the self is adjusted with the contexts he experiences and changes with time. Accounting for the self as a process, he attends to one part of the self which he does not admire as evident in the above quote “I know it was crap”. At the same time, he also attends to the complex, structured of developing himself as a better teacher. This involves the processual, dialogical and social nature of his self, through his reflection on his past experiences that interacts with his future, his students, and the school.

John’s habit of interpretation of good teaching and learning is that it resides in his understanding of his individual students’ learning needs. John reasoned that by spending more one-to-one time with individual students he became more open, and acknowledged the need of him to be more open to change and improve his teaching in order to better suit students’ needs.

If I haven’t spent one on one time with [a particular student who was having difficulty], I wouldn’t discover that, I wouldn’t have been able to adjust my teaching going forward. So I think, you know, the one on one time enables you to address gaps and problems that [my students] might have but it also enables you, it better informs you for your teaching next time around [John, 2, 333]

Consistent with his remarks above, John referred to the importance of developing lessons that cater for “differentiated learning”. Such planning is informed through personal interaction with his students that enable him to diagnose and respond to the varied problems his students face.

Differentiated learning, you know indicates an ability to cater for high-end you know, smart students with a strong existing knowledge versus low-range students that have a poor basic knowledge and that’s the challenge [John, 2, 283]

Differentiated learning is needed and that’s the hard part of teaching because you have to create four different lessons. So I’ve got a lesson that is going to teach Liam, I’ve got lesson that gives towards Peter and I’ve got lesson that kind of for the middle group here and the other group, you know. So it’s hard, you know and I sit in the office and am stressed all the time and thinking, there is a ton of things that I could be doing to make better teaching and will get better results out of it for this class, I just can’t find the time to do it all, you know. I’ve finished marking the test at 2 o clock last night because I’ve promised them that I will get them back to them today [John, 3, 143]

In the quote above, John refers three times to “it” which is a reference to “differentiated learning”. Doing “it” seems to mean he should be responding better in class to the
demands of many individuals with different learning needs that are often not easily identified. His use of “you” and “you know” indicates his understandings of “differentiated learning” as a common or shared goal for good teaching. He views learning as a developmental process involving conversation with particular students, with him able to understand and recognise the different kind of identities of his students. Although John believes that differentiated learning provides better outcomes in his class, he does not describe specific strategies or tactics involving practical work or classroom discussions or objects that he uses in demonstrations, as mediating in these developmental processes. Differentiated learning is an area that the other teachers, Nelson, William and Mark have signalled as important. Instead, John described students’ learning as,

You know, it’s a process, so who cares if they don’t get it all, you know, what I care about is they get a learning process, you know, that they can appreciate as a diversity of skills [John, 4, 176]

In the above quote, John seems to be embracing a theory of cognitive learning hierarchies that subordinates particular concepts and experiences to a higher level of individual data processing capacities and developing multiple skills out of the process. John’s view of learning as a process involving skill development may well be influenced by his thinking developed in his previous job in information technology. His past work experience seems to provide him with a perspective for teaching that can be usefully applied across each of the four subjects he teaches.

John thinks his teaching knowledge and skills develop, and have developed, gradually through discussions with, and by listening to, colleagues as can be seen in the quote below.

The best place to get [ideas] is other teachers, you know, people have done it and, you know, things like conferences and professional development is nothing more than connecting people who have those ideas and so, […] you know, stealing other people’s ideas and, you know, that’s the best learning I think a teacher can have is just talking and listening to other teachers, good ones, you know [John, 4, 240]

John has used “you know” here, showing that this habit of interpretation, and habit of belief, about the best professional development which he is implying that it is understood and shared with “everyone” within the practice. Other teachers in this study offered similar propositions. But it is not clear if these general understandings of the process of personal identity formation as a teacher are the same across different school settings. As John did not make a specific reference to practical knowledge appropriated, shared or
constituted with a physics colleague at his school, this could also indicate that even within the same site, teachers’ habits of interpretation and of belief about their practice may still differ and be enacted differently.

It seems that John has confidence of his knowledge in teaching physics that includes not only an appreciation of the organising ideas of the discipline, but also connections with knowledge in other domains which are not in the course but are of interest to students, as he explained in the quote below. However, John indicated that in his Year 12 class, he felt more restricted in his teaching with respect to attending to his students’ interests, due to his students’ and their parents as well as the school’s expectation to perform well in state wide competitive examinations.

I think you’ve got to get through the content, you’ve got to establish some of those things that are meant for the Year 12 studies but I think in Year 11 you’ve got the luxury that you can afford some time to make it fun and interesting [John, 4, 196]

I think Year 12 is all about unfortunately how do you get them to score, you know and it’s very focused [John, 4, 207]

The strong social expectation from both students and the school is another “shared understanding” amongst the teachers in this study. However, how these shared understandings operate in different schools is equally unclear. For John the performance of the students in his VCE physics classes is likely to play a role in determining his ongoing position as a physics teacher and perhaps define him competitively in the school as a “good” or “better teacher”. He is committed to producing good examination results which is taken to be a normative social action as evident in the above quote with his use of “you” and “you know”. However, as some of the earlier quotes show, even with time-constraint, John tries to spend time working closely with his individual students rather than just following textbook instruction.

Both his practices and his expectations are continuously brought together by John, as seen in his stories. John describes his teaching skills as emergent. He thinks his teacher training assisted him to progress by affording him early experiences of the reality of being a teacher in a classroom.

Definitely aspects of my training were very useful and some were less so but I still think, overall I was quite happy that the DipEd, you know it did as much as it could do in terms of preparing me for teaching but at the end of the day you always you know, when you get out off to school that’s when the rubber hits the road [John, 1, 125]
He valued teacher preparation courses but emphasised it would be misleading for a student-teacher to think that teacher training could directly make them a good teacher. Some theories and models proposed in teacher training did not always work every time. As discovered by John through his actual classroom experiences, although the theories and models he gained during his teacher training did not fully equipped him for his actual teaching, these theories have assisted him to adapt them within his school contexts including the type of students he has.

For him it was, and is now being in a school that shapes him as a teacher. Reflecting on his own experiences, John considers it is important for a teacher-training programme to prepare teachers to be open-minded and to learn from others. They need to be met at least half way by experienced staff who are expected to act as mentors. In this sense John probably had an easier induction than Maria, another early-career teacher in this study. He has been in the same school since becoming a teacher whereas Maria has had to move each year.

John continuously emphasised in each lesson he taught, regardless of what subject he taught, that it was the caring aspect that which mainly influenced his teaching choices and actions.

I think at the end of the day the thing that makes a big difference is if you really care about your students [John, 1, 151]

John is not simply urging compassion or “caring for” students; instead, he is emphasising “caring about”; a serious commitment to the education of the students in any subject he teaches as can be seen in the above quote with his use of “really” to strengthen his view. He displayed his understanding of his duties to his students and his commitment to caring about his students effectively.

When John was asked to compare the specific character and difficulties of physics teaching with the other subject he teaches, he pointed to the need in physics teaching make abstract ideas meaningful for the students.

I think what's difficult about physics and specifically about Year 11 physics where we look at, you know, some difficult concepts, electricity is one, you know […] It’s got some difficult concepts and that I don't experience that in other classes, you know. Other classes are about presenting the material, the concepts are kind of clear, and if the kids put in the effort they can get it. In physics they can put in the effort, study and do all the problems and they still won't get the whole concepts, so how to connect kids with a concept is the
big challenge in physics, and I think that’s where it makes it somewhat unique [John, 1, 414]

John suggests a similar explanation, as discussed by Nelson, that the teacher’s explanations in physics need to be reconstructed by students in conversation with them. Students’ own explanations based on their experiences can be used, rather than literally imposed on students or left to students to construct their own explanation of a phenomenon observed in class (Roberts, 1996).

John continuously emphasises the importance of interacting with students as a way for him to be a better teacher. This was clearly seen in one of his physics classes when he dedicated the whole lesson to giving and taking feedback based on the students’ test. This was an interesting lesson because he used a different approach to Maria when she gave feedback on her students’ test. In the case of Maria, the feedback consisted of reteaching the correct answers to the test paper rather than finding out what difficulties her students faced. John, on the other hand, used the whole period to discuss each question as a problem and asked his students where difficulties arose or things were not clear in the test paper. He invited the students to tell him what he needed to do to help them. He spent time asking individual students; especially those who were not performing well, what they thought went wrong. He also asked some students to explain how they worked the problem out. According to John, this approach was different from his usual approach because for this test paper, he was really disappointed with his students’ results. He said to improve the test results, he believed that there was no point in asking his students to follow the corrections if they did not understand in the first place where their misunderstanding occurred. This lesson was more of a conversation between him and the students. This shows his awareness of the importance of getting feedback from the students and trying to make changes from there. The students remained engaged throughout and attentive to others’ reasoning. His use of Foucault’s technologies of sign systems can be seen when he reorganised his teaching to meet his students’ abilities in learning.

In one other lesson that was observed, John asked his students to create questions for other students on the topic of combined resistance of electrical circuits in series and parallel. There was a lot of questioning and asking and answering of probing questions between him and the students as well as among the students themselves. The lesson
required the students themselves to have a better understanding of the concept before they asked their created questions. This tactic for getting the students to frame questions, and to assess the answers they received, seemed again to successfully involve and engage the students. Although John was probably unaware that this approach would be described as metacognitive he nevertheless demonstrated the importance of this process in his teaching.

Trying to fit in and be accepted in his school, John’s said of his stressful early years,

> [For me] to reach out, and unfortunately as a new teacher you’re always scared to do that because you think it’s going to be viewed negatively on your ability, on how well you can teach, but it’s not. It just takes a while for you to get that into your head [John, 1, 408]

Using pronoun grammar analysis, instead of using “I” to indicate his personal view, his use of “you” seem to indicate John’s view on what would be expected for a new teacher in a school to experience.

5.2.2 Summary of John’s Narrative

John’s accounts are tied to his commitment to continue to improve and better himself in his teaching. His remarks are more concerned with aspects of his development and identity as a teacher in his school rather than as a physics teacher. Thus, his intelligibility of physics teaching was discussed only when prompted. His vision, motivation and practice in relation to teaching physics tended to be generalised with the other three subjects he teaches. Nevertheless, John did talk about the different teaching approaches he needed to apply in his physics classroom.

His habits of belief, which coincided with his habits of interpretation of what resides in good teaching, were general rather than concerned with specifically teaching physics. Perhaps, being a teacher who teaches more than one subject, what matters to John is his identity as a teacher in a school; an identity which is clearly seen through his positions attributing the responsibilities and activities he is involved in, coaching students at sport and coaching staff at the use of information technology. His rights and duties in his school are seen not only as a teacher maintaining student preparation for senior tertiary entrance examinations but also as a teacher who is equipped in all the curriculum areas that he teaches.
His strong personal commitment to his daily routine provides him with an individual sense of agency. John’s use of Foucault’s technologies of production and sign system to understand his perception of his place in the community of his school could be seen when he spends time to help, and better, transform his school through providing his assistance to other staff via the use of information technologies, an expertise which he gained from his previous job. John displayed his understanding and vision as a teacher, which resulted from his whole-heartedness and a strong sense of commitment to exert some community improvement, although he clearly understands he needs to improve his teaching as well.

5.3 Maria

5.3.1 Introduction to Maria

After completing a science degree in geology and in physics, Maria worked in various industries as a marketing analyst for over 20 years before completing her graduate teaching qualifications five years ago. She has since taught at four different schools in the past four years. She has taught physics and mathematics in Year 11 and 12 as well as science and mathematics from Year 7 to 10. In her current small private girls’ NS school, she teaches science at all levels from Year 7 to Year 10 as well as a combined physics class for the small of number Year 11 and 12 students. My conversations began with her at her third, BF school, a small progressive inner urban state community high school that has recently reopened. Her first two schools were private schools. The experiences she gained from these two schools seem to have influenced her perceptions of her next two other schools. She agreed to participate in this research because she sees that doing research is really important and in a way she feels that by participating she can make a contribution to research. She also sees her involvement as an opportunity for her to discuss some issues which might help her in terms of formalising her own ideas and gaining something useful out of her participation.

Vision and Motivation

Maria was motivated to become a teacher because she loved science when she was a student at school. She feels that through teaching, she can use her science knowledge to make her students love science too and help them to get better life prospects and self-perception in relation to science and how the world works. As can be seen in the quote
below, her use of “I” and words “actually” and “really” strengthen the sense that this is her personal view.

I think I actually really love science and I think the more I’m involved with it the more excited I get. Teaching actually allows me to get back into and involved with science in a way that I wasn’t able to in my previous role and so I like sharing that with my students and so if I can get them excited about an idea that’s the thing that keeps me going [Maria, 2, 15]

Maria attributes her personal difficulties in establishing herself as a teacher in her third, BF school to the influences of the school structures, which are affected by social entities such as student’s motivation towards learning. As evident in the quote below, she explained fewer demands were placed on students in her third BF school in motivating the students toward learning science.

At this [BF school] in particular, there is a very low motivation towards science. It’s extremely low. Most of the kids here see themselves in the performing arts, in the visual arts, in the drama. They don’t aspire as a general group to be involved with science and it’s a sort of school that attract people who would probably be drawn to the other areas, not the sciences [Maria, 2, 20]

Maria felt that there should be some kinds of action to be taken by the school in relation to the school’s philosophy and rules, as seen in the quote below. This is in particular in terms of students’ attendance.

There are just so many things that I find frustrating for me. I mean people don’t have to love science but they have to come to school, there have to be rules if they don’t come to school and don’t come to classes and we don’t have that established and at the moment I really find that an issue [Maria, 2, 250]

The “many things” she referred to in the above quote were elaborated in her accounts and included the physical structures in her third school, such as a lack of teaching resources, the social relations in the staffroom, modes of production and teaching expected of the teachers, student/teacher authority issues and a restricted career perception by the students of the importance of studying physics. Students’ lack of passion for learning science is worsened by lack of support from the school administration which prevented her from achieving her potential which includes an aspiration to be a principal in five to ten years’ time. She discussed only in general terms how these powers and influences interacted in various ways, and were manifest in some circumstances but not others, when framing the personal challenges that she faced as a teacher in engaging her students or her attempts to improve her teaching.
During her final month at her third BF school, when Maria knew she would be moving to a more formal mainstream school and teaching students who would be more attuned to her educational aspirations, she reflected;

I’m going to be teaching in the junior forms at all levels of science so I’m going to work on getting more kids interested in wanting to do science later on, so that’s my goal there [Maria, 4, 268]

Despite her disappointment with her third school, her motivation and commitment to teaching was still strong, as can be seen by her effort of moving to a different school, in which she hopes to get better support for the development of her teaching skills. It is clear that Maria sees that the environment and culture of school influences her development as a teacher. From the quote above, her vision to continue teaching sounded positive, perhaps for the reason she was pleased to leave a school in which she was unhappy, in order to start fresh in a new school.

**Development of Practice and Understanding**

Maria recalled her good fortune in having what she saw as proper support and mentoring from physics colleagues at her first two schools: KJ School, a Catholic school and RN school, a private girls’ school in an inner suburb where she was employed on short term contracts.

I had some good people to work with, to learn from and they gave me all the materials so I was able to just deliver their stuff […] you know, I was learning then too [Maria, 2, 157]

She continued to benefit from assistance provided by her mentor at her second school when she moved to her third school. Her first two schools were well-equipped and her colleagues provided shared teaching plans and resources such as notes, worksheets and test papers.

At BF school, her third school, she was the only physics teacher and felt that she did not receive any proper support or mentoring. She has no one to collaborate with and this made her feel insecure on top of her frustration and dissatisfaction with some of her students’ lack of interest and self-motivation. Her use of “me” as seen in the quote below indicates her own personal challenge towards her teaching which she emphasised it with the use of “always” and “actually."
I guess the challenge for me is always how do I get [my students] to actually work for one hour and a half [period] to stay engaged and to get motivated and to actually achieve something. That’s what constantly I’m thinking about in terms of doing it and you know, you came out of some lessons thinking I could have done that even better” [Maria, 2, 62]

She consistently pointed to her concerns about students’ attitudes and motivation in learning physics but without referencing any intellectual rationale or practical understandings or general understandings of her own teaching. She is aware her students’ choice and motivation to do physics is partly at least to fulfil requirement for future entry into specific tertiary courses as seen in the quote below.

The kids that are doing [physics] even the weaker ones, [because] they want to go on to study science or engineering at [university] and so yeah, they’re mostly interested in moving into a science related area at university [Maria, 6, 246]

Maria’s accounts of her agency show little insight into her practical intelligibility for physics teaching beyond her valuing of conducting practical activities outside the classroom and using video clips. She has a habit of belief and interpretation that physics teaching should focus on using practical activities where students are more likely to be able to explore and develop their understanding.

Her practice seems to be greatly affected by the contextual artefacts. These include having English as Second Language (ESL) students, which she regarded as causing communication difficulties for her, as well as the collective lack of material resources for science teaching in the school. These factors are similar to what Kate had to face (discussed in section 4.5) which indicated these practices are influenced by the students collectively, rather than by individual students’ needs.

I actually have to do [the photodiode] as demo because we only have one kit, so ideally you want to have, you know, multiples of those but we don’t have the resources to buy those and it’s unlikely that we’re going to get the resources to do it, you know probably for a number of years [Maria, 2, 218]

In the above quote, her use of Foucault’s technologies of production and power for her teaching suggests that Maria’s teaching productivity is limited by insufficient school resources. While her indexical use of the pronoun “we”, signals her self-positioning with colleagues in a socially disadvantaged school; she does not place herself in any collaborative or teamwork context in the social school setting. Maria sought materials she needed from a nearby school. She positions what she thinks of as a norm for good teaching
which is having good resources with her use of “you know” and signifies her expectation for the researcher to be in agreement with her.

Although she showed herself to be confident in her conceptual understanding of the physics she was required to teach, there was no clear discussion of her pedagogical content knowledge associated with any specific domain or concept in physics that was more or less difficult and engaging for the students. Nevertheless, her habit of belief and her confidence of having good disciplinary knowledge in physics were confirmed by the willingness of schools to appoint her as she taught in four different schools within her five years of completing her teacher training. This sustains her self-esteem as a teacher.

For Maria, the general purposes of school education and tasks expected of her in order to operate at daily level in the classroom have been the main influences on her teaching development. She is clearly enacting her duty as a teacher.

I’ve got my own goals in terms of why I set out to become a teacher so that I could actually influence the way education is going. I need some experiences in actually becoming a good teacher but I also want to have aspirations in terms of actually getting into the management structure of the school system, to be able to fix and change, which I can’t do that at the moment, I can’t be a good teacher [Maria, 2, 337]

From the above quote, Maria’s remark of not able to be a good teacher was caused by not receiving proper support from the school. This habit of belief strongly influences her habit of interpretation of becoming a good teacher. Later in my meeting with her, as seen in the quote below, Maria elaborated that her third school should have been provided a proper, official form of school support in terms of mentoring and team teaching. She thinks teaching in a team is important in the improvement of her effectiveness as a teacher. She sees this as an affordance of a good school which she hoped she would to experience in her new school, with the opportunity to work in a team.

I think team teaching is really the way to go but I’ve rarely seen that happen. It doesn’t happen here [in my current third school] at all [Maria, 5, 244]

Maria displayed her confidence in her intellectual capacity and motivation when she considered she could improve and become a better teacher with her use of “more” in the quote below.

I’m getting more polished as I go and that’s just with me being more confident in what I’m doing. I’m trying to be, I guess the next step for me, I’m constantly reviewing what
I’m doing and saying what could have I done it better or what could I do differently [Maria, 6, 289]

Maria’s reasoning, as seen in the above quote, about her future productivity in terms of meeting the curricular outcomes, and her potency in terms of her power relations and social signing in school education displayed her technologies of the self.

At her current fourth school, Maria expressed her dissatisfaction with the use of textbooks which the school expected for teachers to teach from and be guided by the selected textbooks. This was because the tests and examinations were set out based on the textbooks. Although Maria feels the textbook that she uses for her teaching is excellent, she feels dissatisfied with her colleagues and the school’s uncritical expectation of teaching using specific textbooks. Maria felt she needs to be given more freedom and flexibility to use her own teaching resources as evident in the quote below.

I’m actually teaching at all levels and [teaching here is] very controlled. The whole programme, I mean, it’s very textbook orientated in a way that I haven’t experience it before and all the other schools, they had textbooks but it (teaching) was less focused on textbooks. I mean there was a lot of, a lot more and particularly in year 10 at [my previous school] for example it was all booklet based so, you know, they didn’t use one particular textbook […] The textbook guides everything that we do. We’re using Science Links at the moment. It’s just that it has established here. I can use my resources, yeah but at the same time the tests I don’t write them […] I don’t have any control over the junior stuff that’s all. It’s much more controlled [Maria, 6, 87]

Despite her disappointment with the use of specific textbooks for her teaching, Maria admitted feeling happier with her current teaching than at her previous school. However, she admitted that she had to spend a lot of time in lesson preparation, as she teaches science across all levels from Year 7 to Year 10 as well as a physics class that combined a small of number students from Year 11 and 12. Maria finds this latter arrangement problematic as she needs to know when to switch tasks between the two year levels. She also occasionally faces the same issue as with her previous school when teaching students with English as Second Language (ESL). Fortunately, she thinks this problem is more manageable at her current school than at her previous school, as her current students are more motivated to learn and are good in mathematics and this facilitates her physics teaching. This seems to suggest her assumption is shared with physics teachers who use common formal mathematical approaches to solving physics problems.

I attended Maria’s physics classes both in her previous and current schools. She made efforts in her practice to involve students through discussion and activities. In one of her
practical classes on the topic “motion”, her students were asked to work in pairs. Because minimal instructions were given to the students about how to go about the activity, some students struggled with the activity especially for the ESL students. As a result, they had a slow start. Maria indicated later that she had explained the activity to her students in the previous theory class. She had assumed and expected her students to be able to do it. She wanted her students to think about the task and understand what and why they had to do the task. I observed that while her ESL students had difficulty in doing and presenting their work in the class, they were motivated and wanted to learn.

Maria did not propose or offer any theoretical view about physics teaching and learning. She gave little insight into how a particular teaching tactic or strategy might facilitate students’ learning of physics. When asked what she hoped her students get from their physics education, she was rather surprised and responded:

I want [my students] to be curious about their environment (laughed) [Maria, 6, 453]

In our conversations Maria discussed her concerns that her students might not capture conceptual understanding in their learning of physics. However, in one of her classes that I attended, which was feedback to students’ responses to their test on topic “motion”, she did not display and discuss this with her students. Instead, Maria told the class she was not happy with the results. Her approach was traditional in it that began by presenting her worked solution to each question for about half of the class period. She continued by asking the students to work on further problems from the textbook that they were supposed to have done before the test. Although she asked questions to the class, she was happy with the whole-class answers rather than encouraging personal responses. There was little interaction with individual students that suggested that she was not focused on finding out her individual students’ difficulties. Her teaching approach in this way was markedly different from John (discussed previously in section 5.2).

5.3.2 Summary of Maria’s Narrative

Maria’s accounts are tied to problems she faced that she thinks restrict her development in becoming a good teacher. She had not clearly demonstrated her habit of belief in relation to the nature of physics or the nature of physics teaching. Instead, her habit of belief and of interpretation resides on her students’ attitudes to learning. Even when she was asked specific questions about the inherent challenges of learning physics and
physics teaching, she often switched back to discuss the social problems in her classroom. In a conversation in her third school she remarked,

It’s not about physics and teaching physics. It’s actually just about the [particular] students and keeping them engaged and managing their classroom behaviour which will actually affect the rest of the cohort because they are not disciplined [Maria, 4, 88]

Maria did not elaborate or reflect on her strategic plans for teaching in particular situations for her type of students. Unlike many of the other teachers, she did not talk about her students individually. In this sense she neither elaborated on her practice that illuminated her pedagogical content knowledge nor gave expression to the development of her teaching skills.

Maria’s habit of belief is that institutional orders and class management limit her development as a teacher. Her concern focused on being able to manage her students and classroom successfully in order for her teaching to be improved. She claims team teaching is necessary for her improvement to become an effective teacher, rather than improvement from within herself. She sees this as an affordance of a good school. She did not discuss or refer to the aspects of attending professional learning sessions as part of assisting her in her teaching development. Nevertheless, positive vision and sense of her knowledge in, and the significance of, physics continues to sustain her belief in her own agency as a physics teacher.

5.4 Mark

5.4.1 Introduction to Mark

Mark has an undergraduate degree in science, majoring in materials science. He worked in the field of information technology for about 20 years before he completed a graduate teaching qualification. He became a teacher about ten years ago. He says he studied materials science because he was interested in the “real world rather than in theoretical science”.

Mark has been in the same DR Jewish independent school since he joined teaching except for a year’s break in another school, after which he returned to the same school he is in now. He hopes someone can replace him in his current role as head of science in the school, so that he can spend more time with his students. He taught mathematics in his early years as well as physics. At the time of my meeting with him, he only taught physics
and was the sole physics teacher in his school. He indicated that to avoid professional isolation as the only physics teacher in his school, he ensures he occasionally discusses his work with people in science and physics education. He also attends talks or conferences, as well as his monthly reading group with science teachers. He was keen to participate in this research as another way of being involved with people interested in science teaching.

**Vision and Motivation**

Mark indicated his passion for science motivated him to join the teaching profession. He thinks he transmits his love for science to young people through his teaching. He believes that being passionate about his work has provided him with an ongoing motivation to be a better teacher as can be seen in the quote below.

The important thing is to be passionate and you may not necessarily know the content as well as what you think you need to know but if you’ve got that passion that kids will feed off that [Mark, 3, 458]

The use of the pronoun “you” positions his assertions as normative for all teachers of science and physics, perhaps including the researcher. It seems that the intelligibility of physics teaching for him incorporates what many teachers in this study recognised as important: being passionate about what they are doing.

Mark shows his enjoyment in teaching physics. This can be seen in the emphasis in his accounts about his hopes for himself and his students. He considers the teaching and learning processes that enable his students to understand physics are enhanced by the direct application of physics in the real world. He proposes that through physics he is able to help his students understand how their own and the wider world work.

It’s important that they realise how that knowledge that they are learning has got a direct application [...] so it allows them to take an area of interest and that’s what I try to do, is to get them to focus on something that’s more prevalent [Mark, 3, 176]

“Prevalent” seems to be a term he has used to direct the focus on something that is relevant in the world around them. Mark’s vision is about the ideas or concepts of physics being understood through their uses. As noted earlier, he studied materials science because he was more interested in real world applications of science than in theory. It seems then no coincidence that he emphasises practical activities as projects in his teaching partly
because his undergraduate studies specialised in materials science. He describes his ongoing challenge in these terms.

My biggest issue is finding the time to prepare better lessons such as making more hands-on. [...] I know when I was doing science, when it was a practical, it was fantastic. I didn’t particularly like writing the reports but it was great [Mark, 1, 297]

Mark talks about his collaboration with a university funded “Robotic Project”. In this project, his students worked in a group and designed a robot which was then submitted to an entry to a national competition. His involvement in the “Robotic Project” and many other projects illustrates his dynamic social agency within the school and outside the school. These projects often require staying back late and weekends spent in school with his students. While this really challenges him in terms of his family responsibilities, he said this is necessary to encourage his students to be more engaged in the subject. His willingness to perform and enactment of this duty, which he voluntarily embraces, and which prioritises his students and the school community, illustrates his commitment to advancing his practice beyond that involved in just teaching physics and towards a more holistic approach.

Mark envisages that his students’ involvement in the above-mentioned projects he helps them to better engage in their learning. He considers his students’ understanding of physics is also enhanced through doing these projects as it exposes them to real world applications and uses of physics in real world. He considers that involvement in the projects offers his students opportunities to cooperatively construct understanding and to construct their expertise in the use of ideas emergent through their participation. At first glance, this concept of doing projects seems to resemble the practices of Kate and Maria, who prioritise their lessons with activities outside the classroom. However, for Mark, the activities go beyond those required for a normal physics lesson. As in the quote below, Mark admitted that these projects did involve many hours outside school times for both him and his students.

If you really want to engage students, you’ve got to do [the project] not only in the classroom but outside and sometimes one or the other can suffer and does suffer [Mark, 1, 208]

Even though the long and many hours Mark spent on these outside activities affected his personal time, he is similar to the other early career teacher John in that he sees this as not only necessary for self-improvement, but also for enhancing the schools’
development. His use of the word “really” the above quote indicates his strong view of how he goes about doing activities with his students although he used “you” to generalise others instead of “I”. Nevertheless, he used “me” and “my” as seen in the quote below to indicate that was his own personal story.

For me [my goal] is to dedicate more time to improving my teaching. So that’s my goal at the moment is to focus on my teaching [Mark, 1, 331]

Although he has duties associated with his role as a leader of science teachers in his school, from the above quote, Mark seems more focused on his sense of duty to his students and thus on improving his teaching. This can be seen when he provides outside support to his students by bringing university-based engineers and undergraduate students to the school. They help his students work on the projects. Interestingly, he invited students from other schools to also participate in the projects, which seems to indicate his commitment goes beyond the students in his school and extends to supporting those in school nearby.

The good support and environment of his school clearly contribute to Mark enjoying his work. He values having good relationships with everyone including his family and he mentioned this many times in his conversations. He is happy that his school supports teachers to run co-curricular projects. He sees it is partly an advantage of being in a small school as evident in the quote below.

The good thing about working in a small school, you do have really fantastic opportunities and you know, the one thing that I really like is the fact that it doesn’t matter who you are. You are respected as an individual and you are given the opportunity to have a go. That’s what I really like [Mark, 1, 112]

Mark does not feel constrained by the expectations of others in his school, instead proposing that he values the freedom but also the personal challenges of being an innovator in a small school context.

It’s a school that it doesn’t matter who you are. They value you as a person that you are. They want to know who you are, so they ask you a lot of questions. They try to get into your personal life [Mark, 1, 488]

He proposes that there is a positive aspect to being the only physics teacher in his school, at least in mid-career:
In some aspects, even though I’m a bit isolated, you know, in some ways you can allow your ideas to develop I think because I guess you are not distracted by what everybody else is thinking [Mark, 1, 368]

Mark uses his broader view of his school’s agency, indexed as the collective “we”, to define what he considers to be the causes of the general malaise in science and physics education.

It seems that science has always taken its backseat and the one thing that I notice that really frustrated me is you’re going into any school website […] they always talk about their arts, sport or music and sciences are nowhere. That’s the one thing that frustrated me and it’s a shame. So, yes [this school] we have a lot of projects that are making a big difference. […] It’s a school that is doing a lot of innovative things in science education […] we do innovative real world engineering problems, real science problems solving here and I think that’s I think you know set us apart from other schools but it just means a lot of time, a lot of effort, a lot of those things [Mark, 1, 82]

It is clear from Mark’s account how the supportive school culture has assisted in his teaching development and positive identity formation. Support from school has been consistently discussed by the teachers in this study as an important factor for their positive development as a teacher. This has been an issue for the other teacher, Maria who does not belong to an active group either in or outside her school such as the physics teacher network that can provide support to her teaching.

**Development of Practice and Understanding**

Mark acknowledged the importance of collegial mentorship in the first year of his teaching when he had a physics colleague in his school.

When I first taught physics at Year 12, I was second year out. The physics course had undergone a major change and I was very worried and I remember speaking to a colleague of mine who was my mentor and who was also my supervisor when I did my teaching round here [as a pre-service teacher] and she said “you’ll be fine”. It was still very hard to have that confidence if you haven’t taught at that level and there are going to be holes. So, I remember I tended to make use of PowerPoint, probably too much. But [the PowerPoint] was certainly a prompt for me cause I was worried about forgetting to cover a particular bullet point in the Study Design [a VCE course document] [Mark, 2, 41]

Mark sees his teaching ideas developing as a result of having a “proper mentor”, as well as through his experience of teaching. He discussed the positive outcomes of trying different things in his teaching and through the authority that has come from these experiences, he has developed confidence in the subject content as well as improving his understanding of his students’ difficulties in learning, evident in the two quotes below.
I think there are lots of areas I could be improving but I am better than I was before. I have got to know the students and I know the content better as well and I can present that in better ways [Mark, 1, 288]

In time once I became comfortable with the contents, once I became comfortable with the course itself, once I became comfortable with the sort of questions the students were asking, that was when I developed the confidence to do things differently, to really have them enjoy the subject through not showing them how much knowledge I have, cause I think that is very wrong, but to find out the answers together [Mark, 2, 48]

Clearly Mark feels he has acquired the practical understandings and ability to be able to respond to his students’ learning needs in ways which promote their genuine engagement. To promote such engagement, he considers that “spontaneity” and trying new things are important, which carries the risk that he cannot be sure of the outcome. Nevertheless he seems to feel confident about managing that uncertainty, as the quote below suggests.

For me that spontaneity is really important that comes from students asking questions and from there also I think it’s me as a teacher I think, is having the confidence [Mark, 2, 70]

Indeed, his advice to teachers is:

To try new things and if things don’t work, don’t worry about it because it’s amazing […] how well more often than not, it’ll turn out well and the kids will really, really appreciate it […] make the lessons you know as open as possible. Don’t focus on the bullet points. Design the engaging activities […] and certainly encourage discussions […] challenge the kids to bring in like one new idea that’s happened in the world of physics every week or every two weeks [Mark, 3, 439]

The above two quotes contrast with that provided at the beginning of this section where he described his first experience of teaching Year 12; clearly confidence and spontaneity were not characteristics of his teaching at that time. Then, his approach seemed to be more teacher centred and transmissive. Now he seems to recognise students’ active role in learning, and that discussion among students provides him with important opportunities to get feedback from students.

I think what has influenced me is the students’ feedback and it’s about the body language as well [Mark, 2, 206]

Mark uses student feedback to monitor the learning in his classroom and to design engaging teaching activities.

I observed Mark’s open relationships with his students in the discussions he had with individuals, and groups, before and after classes. For all the three classes of Mark that I observed, there were always probing and stimulating questions and discussion between
his students or between his students and himself. Mark observed this kind of teaching approach was made easier for him to handle because of the small number of students in his class. There were only about 15 students.

I observed that on each occasion, Mark initiated general conversation with his students while waiting for the rest of the students to come and settle down in the physics laboratory. He answered his students’ questions on general things which were not only about physics but also about their particular interests and concerns that related to other ideas they knew or wanted to express. When the lesson was about to start, Mark told his students that he would be happy to further continue talking about their queries after the class and he did. This conversation of Mark with his students is part of the “art of teaching” which William, one of the experienced teachers described as being a necessary attribute for a long term career as a good teacher.

Mark’s habit of interpretation of good teaching and learning resides in his understanding of the differences of his individual students’ needs as seen in the quote below. Understanding individual students’ needs has been a recurrent proposition among the teachers in this study. This was discussed especially by the teachers who have commitment to developing themselves and their teaching as a life-long learning process.

The key point is to start thinking about the kids. That’s each student is different, they learn differently [Mark, 3, 260]

In one of his classes that I observed, Mark changed the second part of his lesson plan. Instead of practical work on resistors in series and parallel circuits, they continued their problem solving activities into more challenging problems. He stated later that he did this because he realised that his students were more focused and engaged in the first part of the lesson. Thus, he chose to extend what they were doing. He observed that it was best for him to be responsive to his students’ active engagement in that particular time space, rather than following a predetermined plan which meant adhering to teaching the next sequence of dot points in the course outline.

I want to make sure because at the end of the day I want my kids to enjoy the [learning] experience. I don’t want them to be put off because I try to cover every single bullet points in depth […]For me, it’s really important that I engaged my students [and] that we cover what we need to cover but at the same time not rushing through cause I have to [Mark, 1, 445]
He said he often found that he had actually covered the key points better when he taught in this way, without the students realising it.

For **me it’s really** important, certainly at Year 11 the way I like to structure it is that I do want to make the physics more engaging. So I do challenge them to bring discussions […] For **me, it** is about ensuring that **they** remain engaged […] I’ve quite challenged them to bring in something that’s newsworthy in science […] cause I find it’s really important that **we** can fall in to this trap that **we** constantly teach. **We** spend so much time on the curriculum and ensuring that **we** meet that, **we** cover the bullet points and in doing so **we** miss those opportunities to discuss the cutting edge, relevant stuff and that’s where, **you know, I** do encourage them to bring in no matter what **it** is, bring it in to class cause I find that, and I said to my kids that “**I** don’t have the answers for everything” but I’m **very** happy to discuss things with them to just see that maybe **we** can find, maybe **we** can understand this better together [Mark, 3, 53]

As can be seen in the above quote, Mark wants his students to enjoy their learning. This is a purpose that he achieves by modelling the discursive world of physics, where anyone may have the best idea, insight or interpretation. He points out that sometimes he allows his students to decide what they want to do in the class even if that means doing something different from his plans. He wants his students to be able to make choices about the best way forward and thus allows them to control their learning, which is consistent with a constructivist approach. Furthermore, he thinks by assisting his students to find and describe their answer to their problems, he helps them develop confidence in voicing their views and ideas in class discussions. Arguably, his approach fosters deeper learning. Nevertheless, Mark also acknowledges that eventually he still needs to address and teach what he had planned earlier in order to cover the prescribed curriculum, given his students will sit high stakes examinations in Year 12; this highlights a common tension in teaching.

Apart from attending professional learning sessions and conferences, Mark explained that his development as a teacher in terms of teaching strategies and tactics in particular topics has been through on-going discussion with other people who were not necessarily teaching in his school.

Mark’s account of his professional identity formation can be described in terms of Foucault’s technology of the self. His technologies of production are seen through the collaborative projects he uses within his classes. His use of technologies of power is seen in the way he uses his influential role as the only physics teacher in his school to provide students with opportunities to enjoy learning physics beyond physics classroom. His use of technologies of signs is evident in the quote where he explains how his representation
of the ideas of physics and science, and their applications in the world, benefits the development of his students’ capabilities to function in society. His technologies of the self are seen through his reflections on the satisfaction he experiences as a result of the success of his physics classes.

[Science] is a matter of exposing the students to [the idea] that science is not only about learning all these scientific skills or scientific methods in the class but applying [them] and also taking into account that you are a part of society so there are rules that can govern your decision making processes [Mark, 3, 94]

Mark expresses little concern about preparing his students for examinations, perhaps because he teaches academically able students who want to be in his physics classes and want do well in their examinations. Given that most of his Year 12 students are committed to high achievement, it is interesting that unlike Noah, he does not feel compelled to focus on “teaching for the examination”.

You start focusing on what will engage the kids rather than what is in the bullet point and then try to find something that will cover the bullet points. That’s what I try to do […] I really want to engage the kids for me at Year 11. It’s critical, at Year 12, I’m more pedantic because they’re going to be examined on those bullet points so I still try to ever possible provide engaging activities but the kids certainly the kids at this school they are more concerned about the exam [Mark, 3, 221].

Mark’s practices are influenced by his habits of belief: that good teaching and learning should involve students’ engagement rather than focussing on covering the curriculum and preparing for examinations. Even when he realised his students are more concerned about examinations, as seen in the above quote, Mark tries to base his teaching on his habit of belief to teach by engaging his students. This habit clearly shapes his teaching actions.

5.4.2 Summary of Mark’s Narrative

Mark displays his commitment, responsibility and whole-heartedness as a person as well as his place in communities of discourse in his school and amongst physics teachers. He enjoys physics teaching as a “form of life”. He was keen to discuss his practice in the context of his school, identifying how his school has influenced his development as a better teacher. Furthermore, having a supportive school community that allows him freedom to choose what he wants to do in his practices provides him with a feeling of fulfilment. Perhaps with the freedom of working on his own as the only physics teacher in the school, Mark did not discuss about needing to work in team teaching.
Mark’s emphasis on portraying the ideas of physics in action in the world perhaps indicates his preference for practical intelligibility of action over the theoretical aspects. It seems he feels that this approach of his teaching helps his students to a better learning of physics.

The intelligibility of Mark’s practices in his physics teaching brings out the affective components of his concerns about his students. This is seen through his continuous conversations with his students on general issues and not only with a physics focus. Teaching is for him a teleoaffective practice; that is, teaching, in itself is satisfying, but he also finds satisfaction through his contribution and commitment to doing projects and involving other students from other schools.

Mark seems to show his strong sense of agency as a physics teacher; this seems to be because he only teaches physics rather than because of any views he held about he nature of physics and how it should be taught. Interestingly, there was no discussion of the philosophical aspects of physics as offered by Nelson and William. Perhaps Mark was not inclined to think this way; indeed as discussed earlier, he deliberately studied materials science in his undergraduate degree because he preferred applied rather than theoretical science. Nevertheless, his description of practice illuminates how he values the importance of his content and pedagogical knowledge in order for his teaching to successfully help students to actually reference themselves in and explain their real world, similar to John but unlike Maria.

5.5 Lisa

5.5.1 Introduction to Lisa

Lisa had been teaching for almost five years when I met her. She was in her second year in her current appointment in a large boys’ Catholic school. After completing her science degree in Victoria, she continued her study in New South Wales to gain her diploma of education. Her first teaching position was in a Catholic school in a low social economic area. She indicated her willingness to participate in this study as she sees the research studies in education as a way to improve teachers’ understanding about teaching and learning processes. While happy to share her stories, at some points she had to be prompted by direct questions to clarify her responses. This probably reflected the novelty of her situation, perhaps being a female gender consideration in a male school for this
research. She taught science from Year 8 to 12 in New South Wales before she came to her current school in Victoria. Currently, she teaches general science at junior levels, and Year 11 for biology and physics. She hoped to remain in the same school for the next five years and hoped by then that she would have been promoted to a head of department.

Her stories do not seem to reveal much about her identity as a teacher of physics. This could be because she is teaching three subjects. She was more inclined to talk generally about issues that beginning teachers usually face in their classrooms, managing students and locating her teaching resources. She did not talk about the differences between teaching approaches and her expectation in moving interstate and the two schools except for why she chose to move to her current school.

I’ve done my master in gifted education and I found that this is a highly academic school. The abilities of the students, which I really really like and the atmosphere and I know of the people who have been here [Lisa, 1, 148]

Her double use of the qualifying word “really” with the pronoun “I” indexes her strong personal choice to be in her current school. Perhaps it was because of good reviews or recommendations that she received from people that she knows who had been in the school. Furthermore, as a postgraduate of gifted education, she seems to be challenging herself to be in what she regards as a highly academic school.

Vision and Motivation

Lisa indicated she is committed to her students’ learning and helping her students to develop understanding of what they learn as seen in the quote below. Her vision is not made explicit specifically regarding her physics teaching, instead she emphasises her aim to make her lessons enjoyable.

I would like them to enjoy what they’re doing and to come out with an understanding of what they’re doing [Lisa, 2, 475]

However, her practices also seem to be oriented in preparing her students for success in senior examinations through giving more topic tests, as seen in the two quotes below, as is expected of her by the school.

Well I guess a high expectation of [this school] of me is my content and the other one is to actively pass it on to my students [Lisa, 1, 125]

Generally, I find that my students have gone reasonably well. I do give them all an opportunity [to do well] whenever they do a topic test. I’ve got them and told [them] at
the start of the year that they all know if they get under 50%, they have to repeat the test. They get a different test at different day at lunch time at their own time but if they get over 50% they’re allowed to repeat the test so they have the option and I find that a lot of the students take that option […] so the second test is always harder than the first but they’ll get the better of the two marks. Then I’d say “well I’m going to take the better of the two so there is nothing to lose by taking a second test” […] For them, it’s a way of learning. They’ve got it wrong, they found out what they did wrong and then they’ve got a chance to do it again in a new situation and that they’ve got it right this time whereas the students who get it wrong, they hear about it but they don’t do it again and don’t always learn from that mistake [Lisa, 2, 456]

Lisa’s use of ‘I’ and “they” throughout her discussion of her use of tests to engage her students’ learning indicates her habit of interpretation that students learn better by redoing more tests. Using Foucault’s technologies of the self analysis, the adaptation of her self to “academic” discipleship defined by student success in individual competitive tests and examinations is expressed in her focus on her understanding of her productivity, signing and power thereby referencing both students and school expectations and the structure and expectations of syllabus and examinations. Furthermore, Lisa pointed out that apart from the school’s expectation of her, her students also have high expectations of her to help them get good results in examinations.

My discussion with Lisa about the examination success has a moral quality reminiscent of my discussion with Noah, the senior physics teacher at her school. Nevertheless, the quote below shows that even with Lisa’s aim to make her students do their best in examinations, she also tries to make them enjoy and understand the subject.

I want the students to do their best as they possibly can in their exam. I think if they can enjoy it, they’re going to do far better. If they can have an understanding in the class without always concentrating for exam because I think a lot of the kids get stressed if they constantly aim at the exam and they’re always worried that they’re not going to pass or they’re worried about giving an incorrect answer whereas if I can take that away and they’re happy and they’re confident, they’ll put down everything that they know and they’ll do far better in their exam and if I spend the whole time aiming at the exam and got them worried that they won’t do as well as they should. I mean how well they do in their exam just, kind of comes at the end of it [Lisa, 2, 555]

Her habit of interpretation is that a better examination result would naturally be obtained when students have positive attitudes towards wanting to learn. This account, which focused on examination in her teaching, seems to be influenced by her school environment. Perhaps, this is a challenge for Lisa, being in a school that she regards as an academic school with high expectations not only from the school but also from her
students. Her ability to sign and produce her teaching, based on Foucault’s technologies of the self, is seen through her effort to make her students worry less about examinations.

**Development of Practice and Understanding**

Lisa recalled her teacher training was useful especially in preparing her how to plan and organise actual lessons by focusing on the types of questions she could ask her students. This in turn helped her to negotiate the construction of social rules at the intersection of necessity and intent in her discursive practice.

We spent a lot of time in my DipEd learning how to plan our lessons. Even with my classes at the moment, I write down the questions that I want to ask and things like that, so I can ask open ended questions, closed questions to anyone and keep on track. So it really helped keep my lesson the way that I want it to go. […] I guess in my first year out, I found that I had to have things so meticulously planned in order to be able to cover what I wanted and in order to be confident to go in, where now, I don’t have to rigorously plan. I can go in having some sheets that I want to do and having activities and just being able to be more confident with what I’m doing and therefore if something comes up, I can change what I want to do and adjust to that much easier [Lisa, 1, 40]

In the above quote, Lisa’s use of “we” to represent a collective experience, perhaps with her other course mates about the teaching education courses, which she then switched to “I” to provide her personal view.

Lisa recalled how she learned “the hard way” during her teaching practicum without having proper guidance or mentoring.

My first day of teaching [as a student teacher] was I think, one of the hardest days of teaching I’ve ever had, walking in as a new teacher, coming in not being given materials, not being given even my timetable, not having a clue what I was doing or having class lists, basically being told “Off you go, go and teach. You’ve got six periods on out of seven”. There were difficult students. There were good students [Lisa, 2, 633]

This was especially difficult, she recalled because there were a lot of autistic students in her class. Fortunately, with her masters in gifted education, it seemed to have helped her. As she recalled, she quickly realised she had to find and acquire different teaching approaches to work with different kinds of students; this was especially true in terms of affording opportunities for her students to participate actively.

She recalled how she values the mentoring she had in her second school from a colleague who was her mentor and also a physics teacher who supported her with teaching resources. However, even having the mentoring, there was no specific reference as to why
she left the school and moved interstate to her third current school. She feels her teaching has developed well with the move to her current school, which has provided her with structured mentoring. It seems that she feels she is in the right place at the right time in her fourth year.

At my second and current school, there were mentoring programmes and that have helped enormously, and made life so much easier, getting to know the school, getting to know the policy, and be it the style of teaching that the students use in the school, what to cover in the program, what I can and can’t do within the classroom, but I guess I learnt very quickly to be very flexible with what I was doing [Lisa, 1, 33]

Lisa emphasised the value of professional learning sessions delivered outside the school. She seems to be confident with her own teaching that she admitted ideas or knowledge shared in professional learning sessions could be what are already expected. She seems not to expect anything new that can challenge and change her practice. However, she recalled one particular session where she distinguished she had repositioned her view about attending professional learning sessions. She was surprised with what she gained from that session which she was able to apply the knowledge to her own teaching.

Most of what has been really helpful was actually external professional development. Some of them are very pointed and they might’ve been what you expected and they’re no good. But a lot of them aren’t what you expected and that can be really good because you didn’t expect to go there and find out something that you end up finding really useful. One example that I had was a PD (Professional Development) that I went to a couple of years ago which was meant to be about podcasting which a lot of what we are teaching is only going to be useful if we had the programme that he was using which I found completely useless but some of the other things that he taught us about putting together presentations and some of the things that we found out from the other teachers who were there were just invaluable with regards to finding resources and creating my own resources […] so I think I took out of something different from what I had expected and I took it back and I apply it to my own teaching [Lisa, 2, 568]

Lisa’s storyline of learning the effective use of the new learning technologies, that is podcasting, in a community of discursive practice outside the school has social illocutionary effect in positioning herself in her teaching. She indexes interchangeably between “I” and “we”, as seen in the above quote, to indicate herself and the other teachers who attended the professional learning session. However, she ended her discussion by indexing “my” to refer to her own teaching. This may suggest there is little opportunity for her to publish and even present this subsequent achievement or for her externally appropriated and internalised skilled knowledge in the institutional practices of her current school.
Lisa described different cognitive styles or preferences (Gardner, 1983) of physics and biology students as a rationalisation for her different styles of explanation in her two classes.

The kids who do physics are a lot more structured in the way they understand things and in the way they like to go about doing things whereas the biology they’re not (laughed) just in regards to I guess a lot of the kids who are in the biology class are a lot more visual learners whereas the physics ones seem to be more kinaesthetic and kind of laid back in writing things down or they like to do things. In biology, they don’t like to do things but they like to see things, like they won’t be able to work out what to do until they’ve seen it as well, whereas in physics you can describe it and they can often visualise it [Lisa, 2, 361]

The “you” used in the last line of the above quote in a discussion of physics teaching practices can be read as referring to conventional or expected or norm referenced habit of belief of a physics teacher who thinks physics students have ability to learn through visualisation in particular with abstract concepts. By indexing “you” which include herself and perhaps the researcher too, her articulation of how students learn physics seems to show that Lisa is developing her identity as a physics teacher by doing normative activities expected of a physics teacher in a class. This can be contrasted with her earlier use of “I” which indicates her personal proposition that the biology students are more visual learners while the physics students do not need a visual presentation when offered a logical description or explanation.

Her descriptions of her practice, evident in the quote below, are presentations of her habit of action in using similar kinds of class activities to rationalise her existing practices.

> It’s easy for the kids that you’ve taught before but for kids that you haven’t, you don’t know what they’ve done and I guess for me, I’ll often use the activities that I’ve done with them. So for example, if I’m looking at electricity in Year 11 and I know an activity that I did in Year 9 with them and I do it with my Year 10 if I’ve got them as well and you kind of say “well, do you remember this particular activity?” and they go “ohh yeah” and so I think they can relate to it even if they don’t completely remember the understanding that they had. They can still remember what they did and it just takes a couple of prompts [for them] to go “That’s right I remember that” [Lisa, 2, 301]

She uses and redoes past activities to trigger her students’ memories of their previous experiences. However, in these accounts of her physics teaching practices and her reasoning, there is no reference here to her tactics for diagnosing student misunderstandings. She relies instead on her perception of what may be effectively performed in her classes. She discussed how getting support from the school administration and other teachers from different subjects, in regards to classroom and
students management has assisted her to understand her students, the school and its culture and her teaching approaches.

I guess a lot of [my approaches] come from talking to other staff, finding out what they already do, finding out what already works in this school, what already the students are interested in, they have already got programmes which give you an idea of how it is but also in that first couple of lessons with your students, there is very little teaching done I supposed. It's more kind of getting around and finding out, so you do some teaching but I also usually spend, even if it's from one year to the next as I get a new class, it's better for the first few lessons that you’re going through different teaching styles in the lesson and see which one that they [respond] positively to and which one that I'm going to struggle [to actualise] [Lisa, 3, 186]

Her understanding of the level of class comprehension in physics seems to always arrive by comparison with biology, the other subject that she teaches. She indicates, as seen in the quote below, that her teaching is mediated using targeted questions.

With biology, I’ll do a lot more concept maps with [my students], getting them to do it that way cause there is so much inter-relation between the ideas whereas with the physics I can give them much more pointed questions to get there, to gauge their understanding and I'll often use a lot of diagrams or a table and you got like a table of vectors and scalar quantities that they’ve got to fill it out and give me reasons why they’re going to each column and things like that [Lisa, 2, 351]

When asked, she explored the differences in her teaching in the two subjects.

With the biology class I guess a lot of things where you can use exactly the same situation for about five different topics but you approach it in a different way [...] whereas with the physics you can’t use the same topic but I can think of multiple situations. I can just change one and so I’ll have my situations and I’ll start and the kids will hear the same situations coming up throughout the year [...] then they just got to remember “well, it applies to this because; it applies to that because; it applies to here because…” so they’re not having to remember ten situations [in physics] to use as their examples. They can just think of one or two and then all of a sudden they can apply them to so many different ways [Lisa, 2, 393]

Although her choice of words is confusing in the above quote, she is proposing that a number of different biology ideas such as organisms and cells can be developed and understood in the real world context. Whereas in physics, while there are many real world contexts in which a given principle can be applied, these different contexts can generally be understood and explained by appropriate application of standard examples.

Throughout our conversations, Lisa pointed out the importance of engaging students’ feedback about their performance. This was observed in one of her classes, which involved a discussion of the students’ performance on a test paper on topic kinematics and waves. Since Lisa was generally happy with her students’ achievements, the feedback
was more on making sure she was reinforcing her students’ correct understanding of the material covered in the test. She prioritised getting feedback from individual students. She started the lesson by asking for answers from the class, rather than giving the answer of the test paper. She put a chosen student’s answer on the whiteboard, so other students could discuss and respond to it. She also made her students define key terms and consistently asked them to give their own definitions from their understanding rather than by rote learning by just recalling and relying on textbooks or teacher notes.

5.5.2 Summary of Lisa’s Narrative

In her accounts of her actions, she acknowledges the teleoaffective structure of mentoring by her colleague. Mentoring and school support play strong roles in her survival in the school and teaching although none of her colleagues are mentioned by name as significant others. The intelligibility of physics teaching for her encompasses similar intentions and goals of the teachers in her school that are perhaps under the influence of, or directed by the normative order based on similar understandings and rules of the school.

Although she confidently asserts the authority of her experience in making her strategic choices in class, her habits of interpretation or belief about what good physics teaching is were not clearly evident in her accounts except for her belief that better examination results would be obtained when students are interested in their learning. She talked generally about her teaching choices and activities and the resources she used in her class in terms of her different teaching approaches of teaching physics and biology. Her stories do not reflect a broader pedagogical content knowledge of physics teaching or social positioning within the physics teaching and the learning of her students.

Greater excitement of shared constituted meaning is expressed in her appropriation and internalisation of podcasting technology obtained from attending a professional learning session. Being in the community of learners that she experienced during the professional learning session have assisted her to develop further her teaching knowledge and skills. Her technologies of the self, could be described that having good support from the school, as well as her teaching knowledge and skills will have enabled success in her students’ performance in tests and examinations.
5.6 Simon

5.6.1 Introduction to Simon

Simon had just started the first semester of a two-year graduate teacher training programme when I met him. His teaching experiences in a real classroom are limited to his twice a week school practicum as part of his teaching training requirement. Simon, like James, another pre-service teacher was a mature-aged student. As part of having his own business, he had travelled and worked overseas for about twenty-five years.

Simon recalled one of the most valuable experiences he had during his undergraduate years were conversations he had with people outside of formal classroom discussions. It was these conversations that he regarded as building on his knowledge and perspectives about the world. Thus, his reason to be a participant of this research study was because he thinks the conversational interviews would help him reflect on education in general which he thinks of as an important thing in his life experiences.

Vision and Motivation

Through his stories, Simon indicated that he decided to be a teacher because he considered teaching a worthwhile profession. His motivation and vision seemed to stem from his strong sense of broader responsibility, identify with his use of “actually” to strengthen his view, to lead himself to a worthwhile life.

I tend to take things quite seriously and I actually care about what I’m doing and I think that’s related to my sense of wanting to lead a life that I feel it is worthwhile. Like I’m not just going through the motions or wasting time anymore and I feel deeply committed and so I think that’s helpful you know. I want to know, yeah [Simon, 1, 109]

Simon claims that his caring and commitment extend to wanting to learn new skills and not simply to apply skills that he already had. In describing the skills he hopes to acquire in his teaching training programme, he distanced himself from broader educational and communication skills, in order to identify skills that are more focused on the practical aspects of physics teaching. As seen in the quote below, he observed the lack of attention to these skills as the collective “we”, a fault of teacher education, the physics teaching community and perhaps society at large. His use of “you know” also positions the researcher to acknowledge the need to focus greater attention on curriculum issues.
think there should be a greater emphasis on, you know, it’s good to have broad skills in terms of imparting physics knowledge but I think that there are a few issues in terms of how general it is rather than, you know, being aimed at, you know, we’re not really all that much curriculum focused [Simon, 3, 187]

Simon views himself primarily as a teacher of not only physics, but also mathematics, as evident in the two quotes below. He hoped that he could pass his knowledge in physics and mathematics to students in schools.

For me, physics and maths are a way into teaching because they are needed and I can be useful. It is something that I can do and something where I will be useful […] I am very interested in the discipline of teaching and I would like to think I can extend that into other fields. I’m committed to learning and that’s something that is really attractive to me about teaching but I’m hoping that again I won’t just be a physics teacher. I’ve already learned that in secondary school, you have to be able to teach combined science and things related [Simon, 1, 67]

I don’t see myself as just being solely a physics teacher. I see myself as someone who would teach physics and maths at the very least but also I see myself as someone who is a teacher first and foremost and then the content afterwards, so I expect to teach other disciplines as well. Yeah I hope [Simon, 1, 190]

Simon’s use of “I” indicates his personal view and understanding of what is expected of him to be able to teach other disciplines beyond physics. This implies Simon was trying to equip and prepare himself for other responsibilities he would expect, when being a teacher in a school. Using Foucault’s technologies of the self analysis, Simon was ready to produce and empower himself to teach besides physics, whatever is expected of him.

Simon reflexively identifies himself as liking working with people. He displayed his awareness of the social need for physics teaching and being a physics teacher. His habit of interpretation of becoming a good teacher resides in his passion for teaching as well as his love of working with people.

It seems that this is a good opportunity for me […] and I recognise that there is actually the need for physics teachers. It’s the skill that is actively been sought in Victoria. They need good people to teach physics and maths. I think I can become a good teacher. I like people [Simon, 1, 61]

In my other meeting with Simon when he had spent more times in school as part of his teaching training, he elaborated a teleoaffective vision of teaching and its craft feel, which has moral and aesthetic dimensions (Sockett, 1987). This was a similar point that William had emphasised.

I still feel very aware of the idea of that teaching is for me, like the actual teaching itself. It’s not just a science. It’s an art [Simon, 3, 260]
Simon recalled a physics teacher from his student years who had his own style in his class. This teacher seems to be a mature role model for Simon.

There was like a sense of cheekiness or humour involved. It was like endless jokes, you know. That guy’s personality had been an influence for me. [...] He seemed very competent and aware of what was happening in the field. [...] I mean he was interesting with all sorts of things as well [Simon, 1, 182]

Simon referred to his school physics teacher who did humour and jokes in his teaching which Simon can still remember. He perceives this skill helped to interest him as a student in the personal dimension of learning. It seems that to have a competent role model has allowed Simon to express his understanding about the process that should be for physics teaching and learning. The experienced teachers in this study, William and Noah also emphasised this point that their teaching contains humour and jokes in order to create better relationships with their students.

So far it’s really [been] about trying to inspire and encourage people and to help them see some value in what they’re doing. [...] For example, I did a unit in sustainable energy with some Year 11 and I try to impress upon them that it was people from their generation that are going to make this difference that basically the planets and everyone needed that, you know. It was those guys who were doing the thinking and it was those guys who are going to come up with the answers and also that I took a very broad approach like I talked, much to the horror of my mentor teacher, I introduced some philosophical, and economic and political angles in terms of sustainable energy [Simon, 3, 286]

Simon indexes his students as “people”, which indicates some affinity with the realist approach of the advocates of the physics in society model (Ogborn, 1978; Osborne, 1990, 2006; Osborne & Dillon, 2008). For Simon, it seems that through his teaching he could extend his students’ physics learning and understanding in ways that would prepare them to participate in wider social debate about how physics works in the everyday world, is used and has changed society, as well as the way people see themselves.

[Physics] wasn’t just about, you know, learning some things from the textbooks so they could pass the test. It was actually related to the way the world operates [Simon, 3, 297]

Although Simon’s view was habitually displayed by all the teachers interviewed, Simon’s elaboration was with the need to expose his students, economically and politically, to the everyday world uses when teaching physics was more transparent than the other teachers’ views. He indicated his approach even surprised his school mentor.
Development of Practice and Understanding

Physics had the reputation and status of a difficult or abstract area that challenged Simon both at high school and in his undergraduate course.

Physics is beautiful […] I have to admit as well, even with science, well it goes back to my undergraduate degree. I had encouragement to keep going with physics because the people around me thought it was difficult, you know, like my father for example but also really, I had a great interest in marine biology. I’m very interested in that but again, you know, physics was seen as a difficult subject, as a hard subject, something that if you could do it, then you are good. I was at a better place, you know. […] So, I think in a way, my choice of physics was something that would ensure that I had a breadth of understanding because it was just one of the things that I was interested in [Simon, 1, 77]

Simon’s reflection on the nature of physics was seen in the quote below. His continuous use of “you know” illustrates his expectation of other people in physics including the researcher to have similar views as his.

I think physics […] is like a language and there’s a great adventure to be had in physics. You know, maths is like a vocabulary and the words but you know, it is something that is very much based on concepts. It’s not just about rote learning things. It’s very much skills-based […] but I would rather learn to teach physics because in chemistry it seems to me, it is much more about knowing facts, you know […] it seems to me, [physics] is much more about problem solving, using conceptual tools and the problems are basically limitless […] it is also getting to live with concepts that kind of don’t make sense or that are irrational and so it’s like, you know, ideas, learning, interactions and academic life are not just about things that can be put together easily to construct some thing, like an architect or an engineer working with known quantity. It is actually about the existence of a mental Black hole, you know. These things you can work with, […] it gives you access to a different dimension if you know what I mean [Simon, 1, 148]

In our last meeting, Simon was concerned about what he observed as students’ lack of interest in school and his teaching mentor’s approach. These concerns seem to be raised by other teachers such as Maria who talked about her students at her third school and Lisa who emphasised students’ interest in learning led to better examination results.

I think really the big challenge is trying to engender a sense of meaning in learning, a lot of these kids see no reason to be at school [Simon, 3, 187]

My mentor teacher’s attitude was “remember this, remember this, remember that and then you’ll be fine”. My angle was you don’t have to remember these things if you can, you can derive the equations from this basic understanding and the classic example with that was, you know, like with electricity, well electric circuits, there’s only really a couple of equations that you really need to remember, then all the rest will come from that because you understand how it works as a system [Simon, 3, 84]

Using pronoun grammar analysis, Simon’s use of “you” illustrates his view of what the normative physics teaching and learning should be like. Simon’s trouble with his mentor
linked to his worries, that he was expected to prepare himself for working in a team and also how to handle with students.

This is also something that’s making me a little bit nervous about teaching as a profession because I like to think that I can be a team player but I think in the end in some way or another one has to fit in as part of a corporate environment. Every school is a corporate environment and you end up, you know, being part of a structure and I’m someone who has worked for myself for many years. So, this is interesting for me how I might, but on the other hand of course being a professional involves, you know, working according to set guidelines so I don’t have a great problem with that. I think, there are multiple issues associated with those problems of engagement and lack of meaning for students in terms of, you know, wanting to learn physics or seeing a point to mathematics [Simon, 3, 222]

For Simon, there is a tension between being a team player in the school and doing the kind of teaching he values which he describes with the metaphor of gardening.

It’s not about delivery of content. It’s about encouraging people to work it out for themselves, and that’s good teaching from my point of view and I know I’ve still got a long way to go in terms of, it’s like gardening you know, you sort of try and pull out some of the weeds and make sure that it’s a nice fertile and healthy environment and then let the things grow for themselves. You can’t make them grow [Simon, 3, 425]

In terms of his views about his teacher training course, Simon reflected on the focus of his course as seen in the quote below.

[The MTeach] course seems to me has got a heavy focus on the linking of theory and practice and you can’t do that unless you have experiences, basically, unless you’re getting practice. So I think the theoretical components of the course require the practical components. I think that it is a cultural sort of shift for me. But I think I feel like I’m going to have some very good level of professional skills and I think that with practice and you know, with experience, I think that I can become a very good teacher. Yeah in three to four years time, I see myself, you know, maybe not a theoretical expert, but having learned through trial and error, I think I can be very confident [Simon, 1, 135]

Simon shows his confidence to develop his teaching skills with his use of qualifying word “very”. He values his teacher training but indicates the need for actual experiences in school, expecting that school culture would change and develop him to become a good teacher. Using Foucault’s technologies of the self analysis, Simon reveals his sense of agency and identity as a good physics teacher as he places himself in real classroom practices.

In our final conversation, Simon expressed confusion about how the learning area of physics and the teacher training in relation to the purposes of becoming a teacher.

There can be confusion between an understanding of the learning area. For example, mathematics or physics and being proficient at that in terms of content and mixing that up
with the fact that we’re here to learn to become teachers. So it’s not about producing something that will be reviewed and accepted and published, you know, as a research paper […] it’s not about that. It’s actually about being able to communicate, you know, the big ideas and the base knowledge of the subject to secondary school students so […] it can be more difficult for more mature aged students. One of the problems that we have, I feel is that we actually care and it’s not even so much about, “oh we care more about the students but we actually want to understand and know and fulfil the tasks properly [Simon, 3, 145]

Simon is concerned that it is the changed nature of students and schooling that is preventing him as a mature age student from doing the good job for which he feels equipped. At this stage he did interpret and identify his problems within the umbrella of the particular influence a school could create.

5.6.2 Summary of Simon’s Narrative

Simon has envisioned his self-improving agency as a physics teacher operating in a physics class through his habits of interpretation and of belief that a good teacher has to be passionate. His sense of what is intelligible in physics teaching seems to be directed by his vision, motivation, understanding and practice regarding his priority to become a good teacher in a school. He has demonstrated his vision to do the good and right things for his students even if that meant to teach differently from what teachers in the school are doing. However, by doing this, it worries him too as he realised the teaching world involves working in a team and according to guidelines; unlike his previous work which was working on his own. His account displayed his use of Foucault’s technologies of the self that through his recognition of being a beginning teacher, he needs to adjust his way of production of his lesson and signing appropriately to fit the school culture. However, at the same time indicate his technologies of power indicates how he decides his teaching according to his type of students.

5.7 James

5.7.1 Introduction to James

When I first interviewed James, he had just finished his final semester of a combined undergraduate science in education degree in which he was studying physics and mathematics. He was a mature-aged student who had previously been involved in manual labour in industry for about ten years. After completing a Diploma in Applied Science at a Technical and Further Education (TAFE) College, he decided to continue studying at a university in order to qualify as a secondary teacher. His teaching had been limited to
supervised teaching practicum experiences which had to be fitted into his timetabled university classes. His account of physics teaching was thus based on his limited experiences as a student teacher and as a school student. I was only able to meet him twice.

**Vision and Motivation**

James indicated he was attracted to becoming a teacher because he was interested in physics and mathematics when he was a student at school. This was a similar point for most of the teachers in this study. The teachers’ interest in science and physics during their student years has been their reason to become a teacher. Like most of the teachers in this study, James hoped that through his teaching, he could make his students develop the same interest as his own interest in the subject. James recalled physics as his favourite subject during his school times because he perceived physics was able to explain everything. He saw teaching as a way that could develop and deepen his content knowledge and hence his own understanding in physics. He shows, as seen in the quote below, that physics explains everything about real world.

“I have passion for teaching and I’m interested to learn because what I found is that physics is, I would say, related to our life and it’s about everything including the universe and anything you want an explanation for, you need to know the basic physics. So to know about the real world, to know about the universe, to know about how our system works, that actually is to learn about physics [James, 1, 9]

James expected in the next few years, as a physics teacher and with his passion for teaching that he would still be continuously learning and gathering more knowledge about teaching.

James expressed satisfaction with his teacher training programme with his indexical reference as “they” in the quote below. He thinks the programme has successfully and systematically prepared him to be in a real classroom.

Everything is very systematic and […] they have done [and covered] every part for my teaching career in every aspect; how to deal with students, how to go with content knowledge, how to deal with colleagues, I would say they have covered every part [James, 1, 36]

Although James is happy with his teacher training courses, he indicated his ongoing concern about establishing his authority in the classroom as evident in the quote. A similar
deep “insecurity” (Bullough, 2008a) was recalled by many of the teachers in their initial years.

There are some issues like the main issue I would say for teaching is classroom management. So some of [my course mates in this course], they didn’t find it comfortable or they didn’t get the skills to handle a class [James, 1, 56]

James talked about some of his peers in the course who faced difficulty in the teaching training course, to such an extent that some had to withdraw from the course after their teaching practicum. He considered himself, and may have been told by significant others, that he was fortunate in that his previous work experiences equipped him with management and interpersonal skills. His reasons point to Foucault’s technologies of the self that in his knowledge and appreciation of the power of physics and the skilled knowledge that he had gained in his previous job will enable him to become, with practice, a good teacher.

James offered his interpretation of the problem faced by his course peers and the task of becoming a teacher as seen in the quote below.

The problem is the ‘pedagogical content knowledge’. How are we going to teach? So it is, you can’t teach someone the pedagogical content knowledge. It is something that you have to acquire with your experience. Moreover, it is not only content knowledge; it is something you need to have, like organisational skills, time management skills, interpersonal skills, communication skills [James, 1, 89]

For James, his habit of interpretation of becoming good teacher is being skilful and capable of building on a conception from his own experiences in order of preference and to act accordingly. His orientation to his transparency on the importance of being skilful, however, did not necessarily point to his habits of action. Such an orientation Bourdieu (1990) has called “cognitivist”. However, many elements of Shulman’s pedagogical content knowledge (PCK) including the framing or staging of a lesson or understanding student background seem to be absent in James’s account. His habit of interpretation resides in being skilful, such as in managing time, classroom and students. These seem to influence his vision of how he sees effective teaching should be.

Development of Practice and Understanding

James thinks of physics as a framework of key ideas that have to be applied to every day experiences for students to understand and be able to explain how things work in their material world.
With physics, I would say [you] cannot just read the book and deliver the knowledge to your students. I would not downgrade some other subjects but in physics you need to have what you call the concepts and as a teacher I need to have the concepts clear, very clear and if the teacher doesn’t have the concepts clear, the students then would not get clear conceptions. It’s my view. It’s only my view is that like in chemistry and biology you can memorise, some parts yes you need to understand but there’s some memorisation parts. For physics like Newton’s laws, you cannot memorise it, you have to understand to get the concept. Why, if you are pushing the brick, you’re leaning forward? You can discuss it. you can talk about it but to get the concept, a student must stop and think and go back to his experience why is this happening? He has to ask. He has to do more critical thinking [James, 1, 177]

James sees his role as a physics teacher to be the presentation or representation of the physics ideas, as discussed in the quote above, in a way that makes them clear to the students. This, he realised, requires lots of directed experiences for students such as hands-on activities. A similar point discussed by many of teachers in this study.

For physics, I think it is not rote learning. To understand the concepts, there should be lots of hands-on activities. From the activities, we give the students experiences. From experiences, they will learn the concepts [James, 2, 5]

He mentioned that doing simulations and hands-on activities could lead to students’ discussions. He explained that with experiences and discussion gained from the practical activities, students would be interested to learn more, and better, and be able to connect lab time to their real-life experiences.

You need to tell them why they need to do this and also before a practical, I tell the students that it is not about completing the activities in the lab but it is about what you learn from the activities that after the activities, you must find what is the reason behind what you did [James, 2, 26]

In terms of Foucault’s technologies of signs, James describes his ability for signing and representing ideas of physics for use in the world although it is not yet observed being a pre-service student teacher how much he would or could do this.

James discussed the need for teachers to continuously reflect upon their teaching. The need for extended shared reflection in class was the main message he took from his teacher training.

[The teaching course] asks for reflection that you need to submit. Sometimes in presentation you have to talk about it. So reflection is everywhere. So in the course, they really want reflection. Because they say reflection is the only way to improve, to improve your teaching that sort of things. So, feedback and reflection altogether would make teaching better and show how I could improve myself [James, 1, 159]
In terms of the school’s expectation, such as producing good examination results, James recognises the threat to student learning, and his own, that can be imposed by these expectations.

Some schools expect that students will get higher marks in tests (laughed). In my view, the expectation should not be getting higher marks but I would say the expectation should be how students learn, getting the physics concepts clearly in their minds, and how a teacher can makes physics interesting to students, to get them to learn more about physics [James, 1, 301]

5.7.2 Summary of James’s Narrative

In his limited account, based on only two meetings with him, James described his moral formation and agency in becoming a physics teacher in terms of the development of an extended reflexive consciousness. This could be as a result of how his teacher training that had emphasised the importance of reflection.

James’s exposure to teaching was only based on his teaching practicum. Hence, his stories were limited to his own experiences so far. He seeks to build his knowledge of teaching around the feedbacks and the explanations of the concepts of physics that he has been taught. Although he acknowledged that his teacher training programme could not fully equip him for a “real” classroom, the training has reinforced his confidence that he can rationally order his own goals and act accordingly. This concurs with how he confidently views himself in the next five years, to be still learning about making teaching choices within a school culture. The intelligibility of his physics teaching seemed to involve the acceptable intentions and actions of a physics teacher in a school. Unlike most of the early career teachers, James did not mention about the need of mentoring or team teaching as a way to develop his teaching.

His descriptions with the use of Foucault’s technologies of the self seemed to evolve as a result of his past working previous experiences that equipped him with necessary skills to become a teacher.

5.8 Concluding Remarks of Early Career and Pre-Service Teachers

Interestingly, three out of the four of the early career teachers and both of the pre-service teachers discussed in this chapter are all mature-aged entrants to teacher training. These
five teachers’ previous work experiences increased their ability to discuss and reflect upon their practices.

The ability to manage time effectively, as well as managing students seemed to be the skills that these teachers prioritised as necessary to develop effectively. This is similar to how the experienced teachers recalled these same skills as essential during their early years of teaching. The aspects of developing teaching skills like time and student management, seemed to be the common focus of these teachers in order for themselves, and even others, to be regarded as good, effective teachers. Perhaps because of this, the aspects of physics and its structure in the physics curriculum were not discussed in detail even when asked for.

In addition to these managing skills, my discussions with John and Mark seemed to indicate their main focus is to improve their teaching by learning to understand individual students’ needs and by building a good rapport with students. On the contrary, for Lisa and Maria, having these skills is seen to be the way to produce effective lessons rather than improving their teaching.

The two pre-service teachers, Simon and James spoke confidently even with their limited experiences of teaching practice. They seemed to indicate that their past work experiences had, in general, assisted them to reflect and value significant others such as their peers in the teaching course and the teachers in their practicum schools, in the capacity of them becoming a teacher. Reflection by Simon and James seems to show their ability to know and thus tell themselves of their capacity in how to become good teachers. Perhaps, their movement from one field to another provides a better capacity for self-reflection than those teachers with a narrower range of experience. Yet, because I only had two meetings with James and three with Simon, with no opportunity to observe their teaching, there is no clear indication if their movements to the teaching field assist in their actual practices. For Simon, the teaching profession could hopefully give him worthwhile lived experiences; for James, through teaching, he hopes to develop his own understandings of physics. Nevertheless, their storylines show they are open-minded and show their commitment and willingness to adapt and change accordingly with respect to what is expected of them in their practices.
Overall, these six early career and pre-service teachers position themselves as a teacher in a school rather than as a physics teacher as represented by the illocutionary forces they shared in their storylines (Harré & van Langenhove, 1999). There is a commonality to these teachers on how their school communities influence their individual agencies as a teacher in a school. There is a common vision to transform oneself to be a better teacher which is shaped by not only one’s own desire and vision but also by a school’s communal powers (Harvey, 2002). The teachers perceive the importance for a community to learn with. The teachers’ practical consciousness about their practices contribute to their identity formation which are influenced by daily school life as well as by how they perceive and make sense the practical intelligibility of physics teaching in their own schools.
Chapter 6  Discussion

“…Teaching is a cultural process and a public activity, being a teacher is both internal self (one's own values and experiences) and external self (a comprehensible engagement with other teachers, children, parents, etc. whose views either tally with or deny aspects of one's sense of being)” (Pearce & Pickard, 1987, p. 42).

6.1 Introduction

This chapter presents a discussion of the key findings that have emerged from the teachers’ accounts. To address the research purpose of this study, to explore what the teachers consider has shaped their practices inevitably focused on what they valued and believed to work best in their own practices. Their social reasoning in our research conversations was not necessarily taken to be a simple statement of the causes of their actions, but rather their explication of their agency was taken to afford an exploration of social structures that shaped their personal professional identity formation. All the teachers shared what they regarded as important and made sense to their practice, and hence the intelligibility of physics teaching in their everyday school practices.

This study aimed to explore the fine grained complexity of the identity formation of the physics teachers through their storylines, made meaningful through interpretation of their personal positioning in their storylines and the illocutionary force of their utterances (Harré & van Langenhove, 1999). The different positions the individual occupied in their own episodic storylines were taken to be formed at the intersection of their purposes or motivations and the everyday obligation of meeting the expectations of generalised others in the dynamic process of their personal professional identity formation.

“An individual emerges through the process of social interactions, not as a relatively fixed end product but one who is constituted and reconstituted through various discursive practices in which they participate” (Harré & van Langenhove, 1999, p. 35).

I did not aspire to describe the Melbourne teachers in this study as participating in a universally understood practice across all cultures. I have been from the outset interested in their construction of their own personal agency within the social structures and horizons of significance provided by their culture which deals with rules, values, traditions and norms in their community of practice (Bonnett & Cuypers, 2003; Taylor, 1991). The exploration, afforded in their narrative accounts, of these structures was central to my interest. I was attracted initially to the potential usefulness of Harré's
discursive psychology and positioning theory as an analytical tool. This is particularly so with the assumption that the identity formations of the physics teachers were culturally inclusive and socially constructed. This culturally inclusiveness and social construction happened at the interface of their private purposes or motivations as well as public necessities of which were applied to the practical intelligibility of physics teaching in their everyday practice. The limitations of the dominant tradition in psychological research as a universal science, which preferences the search for fundamental principles or laws of perception, cognition, motivation, and learning were evident to me.

The numerous problems that plague traditional attempts to establish a culture inclusive psychology (Eckensberger, 2015; Gergen, 2015) beset attempts to establish a culture inclusive of a psychology of physics teaching whether the inclusion be derived from a universalist or a culturally particularist standpoint. However some of these problems exist in the assumptions within which inquiries have taken place. Conceptions of representational validity, empiricist methodology, dualism, rights to representation, and cultural variability have traditionally all been in play in the appraisal of studies such as the current one. From the constructionist standpoint adopted here in exploring the culturally inclusive everyday intelligibility of physics teaching, the focus of the co-constructed accounts has been on the issues of the teachers’ pragmatism and how they value their potential, strength and capability as teachers. The focus adopted does legitimate the full range of voices concerned with the psychology of professional identity formation across cultural contexts but in the end we are left with an image of individuals or groups motivated to generate multiple realities for disparate ends. This constructivist standpoint may be a useful beginning to cultural inclusion in physics teaching but it is scarcely an acceptable end. The crucial need is productive dialogue across enclaves of concern, in teacher education, and in my own work. Eckensberger (2002; 2015) reflects on the role of culture in psychology which he argues that “the human/cultural perspectives basically deal with the creation of personal and cultural rules and meaning systems, and therefore constitute the “realm of reasons”, whereas the natural sciences perspective is based on natural laws and the “realm of causes” (Eckensberger, 2015, p. 113). The “reasons” the teachers present for their actions cannot be treated as causes and at times seemed to screen or disguise their motivation.
Constructivism has had a particular psychological meaning in science education research associated with the recognition of prior cognitive knowledge that individual students bring to concept acquisition in science classes (Roberts, 1996). This particular meaning draws on a broader social constructionist theory of teaching and learning and enquiry that Gergen (2015) associates with the convergence of a number of movements including scholarship in the history of science and sociology of knowledge and points to three shared agreements: the social origins of knowledge, the centrality of language which is central to Wittgenstein’s view of language games as embedded in “forms of life”, and the politics of knowledge or the implications for cultural life of taking any truth claim seriously. Gergen (2015) argues the “universalizing posture owes its existence, in important part, to natural science research and to the supporting role of 20th century philosophy of science” (Gergen, 2015, p. 95).

On entering the behavioural setting of physics teaching and the moral context of physics education, the teachers described the major personal challenges of meeting often tacit social norms or practice orders of physics teaching. Physics teaching and their educational purposes in the teachers’ stories are studied together by analysing the moral context of each teacher’s intentional actions that is not bound to role theory alone. Each school, and the community and society at large that it serves, is described in the teachers’ accounts, with several notable exceptions, as offering multiple affordances for a challenging but meaningful and satisfying life. The accounts of their teaching practices and the outcomes of physics education they were producing in their students’ learning were framed in stories. They either located their professional agency in normative discursive circles in their schools, after Clandinin and Connelly (1996), I will describe these as “cover” or “sacred” teacher stories or “secret” stories in which they sought involvement and engagement in their exposition of physics as a field of study with their students or less often, as remarked, in their personal motivation. These stories seemed to describe mutually exclusive local moral contexts that they inhabit in their schools.

6.2 Tools for Analysis

Although the practical intelligibility of physics teaching, accounted for in the conversational interviews of these teachers, aligns with similar discussions already noted in the research literature, positioning theory in this study has allowed me to locate the
teachers’ identity formation in their personal storylines of their doings and sayings in relation to their everyday practices. From my understanding of positioning theory, as an approach and as a tool to analyse the teachers’ accounts, the teachers positioned themselves in a situation, which reflected their place in their setting and contexts. The teachers’ accounts included their personal experiences, preferences and capabilities. Their positioning in their accounts also depended on their context and how they value and are valued in their own local community of practice. Using Pronoun Grammar Analysis (PGA), the use of “I” has been taken to be an indication of a teachers’ own sense of agency (Mühlhäusler & Harré, 1990b). The application of PGA has also assisted in locating the teachers’ technologies of the self.

Foucault’s technologies of the self (Burkitt, 2002; Foucault, 1988) informed my analysis of the teachers’ positioning in relation to their individual practices and their agency in each moral context they introduce. The framework supported a better understanding of when, what, how and why the teachers used four kinds of reasoning about production, power, signing and self-worth in their accounts of their doings and sayings. This study also employed Peirce’s (1931-58) distinction between habits of mind: habit of interpretation, habit of belief and habit of action, and the tensions that can often be observed between these in the teachers’ accounts to interpret how the teachers attain, and permit, the effects of their actions through their own means or with the help of others in order to sustain and transform themselves as teachers. My application of these two descriptive frameworks varied for each of the teacher story. By means of the mutually determining triad of position, storyline and relatively determinate speech act the conversation were analysed for their episodic structures. This depended on each teacher’s stories, and the interpretation of their meaning was limited by my comprehension of particular everyday social realities, cultural contexts and references, that they assumed or sought to explain.

The first order positioning of the author by the teachers in their accounts was understood loosely as described by Clandinin and Connelly’s (1996) functional typology of teacher stories: cover, sacred and secret - in alignment with the broad system or institutional “rules” or norms that organise their lives, with their locally shared norms of how we do it here, and with their reflexive positioning, culture and private discourse. This analysis assisted in the construction of more direct and focused questions at later meetings with
the teachers. By drawing upon the teachers’ responses from their previous interviews, the more sacred stories started to be shared. Although the sacred stories still tended to be common ones, the descriptions about the teachers’ practices and their general pedagogical approaches, were more elaborate. With an average of four meetings with each of the teachers, except the two pre-service teachers, my successive meetings gradually opened up the teachers to talk more about their sacred stories in which their habits of belief were embodied and embedded.

The analyses of the teachers’ accounts of their practice explored aspects of their agentive spaces and their background (Shotter, 2013). As Shotter (2013) argues, although agentive spaces and other matters were often not fully shared and discussed, as found with the teachers in this study, they nevertheless were felt by the teachers to have directed and shaped their lives (Shotter, 2013). This study explored the teachers’ construction of their social orders or “rules” of their purposes or motivational intent and social necessities. I have described the agential social space of these teachers, in their own stories by treating their accounts of their roles and positioning as complementary in their accounts of their technologies of the self, their knots of reason, about their productivity, signing, power and self-worth, in their schools.

6.3 Overview of the Findings

In this section, the key findings are highlighted, which will be discussed in detail in section 6.4. The overview of the reflexive positioning of descriptions each teacher and their episodic structures uncovered is discussed in the last two chapters. Each has been viewed through the dimensions of vision, motivation, understanding and practice. Chapters 4 and 5 grouped the teachers by the number of years they had taught. Chapter 4 was devoted to the exploration of the stories of experienced teachers and chapter 5 to early career and pre-service teachers. The teachers’ accounts, in chapter 5, aligned with my initial expectation that there would be similarities among the experiences of the early career and pre-service teachers. I expected an enhanced practical intelligibility of physics teaching in the accounts of teachers with years of experience. The findings illustrate that the teachers’ agency is dynamic social, that does not simply reflect years of classroom experience in the “role”. Reflexivity is shown to be mediated by complex situational responses that interact with personal attitudes and past experiences. These general
interpretations of the teachers’ accounts of their practice are consistent with more recent research (Mansour, 2009). The teachers’ accounts of their practices are situated and informed by multiple influences arising at various social ontological levels and sources. These include discussions and events that take place in the classroom, the school, and the community, as well as society and the broader culture.

In the data, there was an intriguing lack of detail that would clearly distinguish and characterise these teachers as physics teachers. Multiple opportunities were provided through a range of techniques designed to encourage the teachers to talk elaboratively about aspects of physics, physics teaching and physics education and its nature. The techniques used were personal meaning maps followed by a range of stimulus questions and targeted prompts, and asking focused and direct questions. Even with these varied options, minimal personal reflections were given on the explanations of core physics knowledge, distinguishing properties of good physics teaching and even specific physics teaching activities. In brief discussions of lessons observed and brief asides, a shared understanding existed of physics teaching as a formal exposition of the elegance and simplicity of scientific laws and an acknowledgement of the facility in solving standard quantitative problems was accepted as an inadequate criterion for functional understanding, as well as the motivational significance of stressing the social importance of the applications of physics concepts ideas. However, the details of stressing the mathematical character of physics and the need for repeated practice in interpreting physics formalism in algebraic and diagrammatic representations and difficulty of relating these to real world were not elaborated in the teachers’ accounts. While many references were made to the need for students to be intellectually active to develop functional understanding, the cultivation of scientific reasoning skills that required qualitative reasoning and verbal explanations were not rehearsed in our conversations.

The conversations in this study, including the pilot study, reveal few personal details of their physics teaching and its epistemological challenges. Although the teachers were conversant with, and referred to, various conventional practices employed in their physics classes, their accounts did not distinguish these practices from those in other science classes. The teachers’ stories, in particular the cover stories can be easily seen to be about common place reasoning and features that any teachers, regardless of what subject they teach, could freely have discussed.
The teachers’ stories seemed to indicate that they chose to speak about their personal everyday involvements as teachers within their local school culture which informed their physics teaching activities and events. They seemed to have assumed a shared common understanding and appreciation of physics and physics teaching with me, a university employed physics teacher/researcher, albeit from Brunei. However, this does not in itself explain why they did not rehearse this understanding and appreciation or express curiosity about physics teaching in Brunei. It is not that they saw physics teaching as a personal afflication, not to be spoken of, they did strongly reference the significance of physics as an intellectual discipline in their work as teachers, and as an important social organisation unit, usually within science, in their school. While many of these teachers at least would probably have spoken to one another outside their schools about the State hegemonies and the strengths and weaknesses and problems and prospects for the proposed Australian National Physics Curriculum in advancing physics education and as an expression of their personal professional education agency, they did not do so with me. While this particular phenomenological inquiry did not focus on policy implications, according to Shotter (2013), “this does not mean that [the teachers’ accounts] limited, partial and situated [as they are, that I report here] will be of [little] or no use” (p. 152). They are basically what is essential in physics teacher education if teachers and physics educators “we are to move from simply being ‘caught up in things’ [happening to us to being engaged in physics teaching to as a] particular sphere of activity” (Shotter, 2013, p. 152).

The teachers habitually tended to explain things in generic terms. The teachers’ accounts are governed by habits: of action, of interpretation, of belief (which for this thesis include true belief) (Heiskala, 2011; Peirce, 1931-58). For example, the meaning of the teachers’ shared belief that “physics is difficult”, had to be explored for its different personal interpretations. It had to be explored in order to better understand their moral contexts of intentional action. The general discussions by the teachers related their habits of belief to their habits of actions that they said they had found worked well in their classrooms. Less prominent in these accounts of their positioning are descriptions which led to “an intersubjectively legitimate, [reflexive] expression of their [true beliefs], inner sensings and feelings” (Shotter, 2013, p. 133). They often tended to use the rhetorical descriptions of teaching, of their school and the knowledge domains of science and physics as cover stories couched in terms that fused habits of interpretation and habits of belief. This agrees at one level with explanation of their identity formation by Giddens (1991) that
“in ‘doing’ everyday life, all human beings ‘answer’ the questions of being; they do it by the nature of the activities they carry out” (p. 48). The respondents recounted what was involved in relation to the practical social purposes and goals side of the subject in teaching physics in schools.

Nevertheless, the findings also suggest that the teachers can be supported to reflect upon their motivations and actions in the symbolic and imaginative spaces of physics teaching and start to discuss openly their stories, as anticipated in the literature (Clandinin & Connelly, 1996; Wood, 1992). They can, in their stories, “orient or relate [themselves] to [their] circumstances, [less] in terms of what [they] think they must be like, [and more] in terms of what actually they are” (Shotter, 2013, p. 133). This study found that the teachers were more inclined to share more, when they were provided with time and more opportunities to recall experiences that played a role in, and influenced, their practices. They discussed stories beyond the cover stories and revealed their feelings and their resilience towards their work and development. This suggests the significance of acknowledging “felnness”, - the subjective side, in research (Linehan & McCarthy, 2000; Sullivan & McCarthy, 2004) which, in this research, sought to take account of the influences on the complexity of the everyday space.

Most of the teachers, with a few exceptions, as discussed in the previous two findings chapters, did not seem to think through a physicist’s “physics teaching” lens and were inclined to talk about how their practices were intelligible to them, within the institutional order of the school, and/or their students’ motivation or concerns in general terms. Shulman and Shulman (2004) reflecting on their own research about learning to teach, commented on the complexity of the agential space of teaching in today’s schools:

"From the perspective of teaching and teacher learning, we became far more conscious of the complexity of learning to teach in a theory-intensive reform context than we had been earlier. While ‘the subject matters’ in these settings, there is so much more going on simultaneously that at times the ever-important content differences can be swamped by other critical features of the context” (pg. 269).

The development of practical epistemological reasoning of physics teaching was emphasised in the domain specific research agenda of Shulman (1986, 1987a), in which exemplary accounts of teacher knowledge were sought. Shulman and Shulman’s more recent analysis at least concedes it is not the teacher’s only social or cultural reality. In the physics teachers accounts of their agency in this study, they explicate their moral craft
knowledge in everyday contexts and as Shulman and Shulman (2004) observe above, the problems of the practical application of this knowledge to various social necessities can subsume or even displace practical epistemological reasoning in more difficult schools.

Generally speaking, the teachers reasoned that their reality must correspond to, although not to be determined, by their operating circumstances or structures, and similarly their thinking about physics teaching and student thinking should correspond, but not be restricted to established practices or preconceived ideas of physics. Reciprocally, they also seemed to think of their embodied and embedded practical intelligibility of physics and physics teaching and hence their identity as physics teachers, that they were describing in their accounts, and those presented by others, were preconceived ideas to which reality must correspond or be attached. This seemed to lead them to try “to live in [the theories of the institutional order of physics teaching, instead of] to live alongside them and to use them as ‘objects of comparison’” (Shotter, 2013, p. 133) with others in the constitutive order (Rawls, 2012). This seemed particularly noticeable, as an occupational challenge for isolated and beginning physics teachers where such collaborative construction and reflection was not a feature of their everyday discursive practice.

First, most had no formal education in the history and philosophy of science or physics. Nelson was a clear exception here. However, the experienced teachers would all have participated, at least tacitly, in the often intense arguments surrounding the contemporary history of the physics teaching curriculum in Victoria including rationales for various major reforms designed to better serve public appreciation and pre-professional training in physics as a field of academic study and also to better align instructional approaches and student learning. This understanding may well have been considered to be the substance of local politics and have not of interest to a visiting researcher concerned with their autobiographical accounts of their personal identity formation as a physics teacher.

Second, the teachers’ stories do not attend to their practice, beyond their daily actions. It may be supposed that it might have been difficult for some of the teachers to openly share, unrehearsed their reflective positions on the nature of physics in their physics teaching. However, some of the experienced teachers, Nelson, Noah and William in particular have participated in conversations like those reported here with other physics teachers in various setting outside their schools and have experience in autobiographical deliberative
positioning in “this is how I do it” presentations at professional association conferences that relates their physics teaching practices according to the rules of prescribed examination syllabus and their conceptions of the nature of physics as a discipline and physics education. The storylines presented by the physics teachers were generally of actions rooted in prior practices, or in reaction to them, and describe a unitary self as a teacher perhaps because this was perceived as the initial research context. Their purposes were generally expressed in a “because” rather than an “in-order-to” motive (Heiskala, 2011). Given that they felt they were entailed in a tangle of social actions with others (Shotter, 2013, p. 133) in their school with students and colleagues, their “because” statements could not necessarily be taken as the formal or final “in-order-to” motive for their actions. In relation to changes in their own and others’ professional practice they saw as important, there was a felt sense particularly among the less experienced teachers in their discursive positioning of their own, less than adequate, understanding of the shared reality or meaning. The self, Davies and Harré (1999) suggest, can bear its own specific causal efficacy. All teachers, with different frequency, and more commonly among the very experienced teachers, spoke in the first person about their capacity to cause their habits or changes in their habits in their own discursive and non-discursive practice. These generally ascribed their agency to a unitary self and their reasons as causes. However, I had a strong sense that the teachers’ reasoning generally did not convey the full accounts for why they were doing what they were doing or not doing. Each teacher’s first inclinations were to share a version of the common cover stories as their self.

Third, these teachers perceived themselves, first and foremost as being a teacher in a school. They fluently shared their cover stories about their life as a teacher in a school and of being a physics/science teacher organised by the dual orders that managed social maintenance and social honour of status. The school afforded physics teaching as the vehicle for achieving self-improvement. However, agency for general objectives and vision in their teaching was conferred in the larger discursive circles in the practice community of the school or the science department rather than self-elected in the physics classroom. Personal honour and status in the school was identified and characterised in the teachers’ stories with the attainment of broad role-bearing social responsibilities. Recognition of expert craft skills in teaching physics occurred in the teachers’ discursive circles outside the school.
Responsibilities and Duties

Positioning theory has assisted in the analysis of the data by which the teachers could be better located in their own account of how their habits of belief informed their practices. This enabled identifications of the teachers’ perceptions and stories of how they described their responsibilities they accepted and duties required. What the teachers do and actually perceive they can do is influenced by their understanding of their responsibilities and duties, obligations which they perceive have been required or imposed upon them (Harré & van Langenhøve, 1999).

Discussions about the duties of teachers to the institution of the school, and their responsibilities to their students as agents in their own learning, were equally discussed by both the experienced and the early career and pre-service teachers, as can be seen in and from their cover stories. The teachers’ acute awareness of their responsibilities and duties can be seen to be influencing their accounts of their practices. Generally, the teachers’ accounts emphasise their performative self-positioning among the complex duties and responsibilities in their everyday actions which they see as flowing typically from established practices in their school.

Interestingly, the sacred stories revealed in the research conversations seem to indicate the teachers were inclined to discuss their responsibilities in the generic local moral order, rather than their specific responsibilities to their students. The early career and pre-service teachers frequently discussed what they expected their responsibilities and duties were in schools; in particular, in receiving personal mentoring which would support their self-improvement by exploring their own ways of teaching and with desired teaching resources, as well as being afforded opportunities to attend professional learning activities outside the school. The experienced teachers saw mentoring as a responsibility that they valued and as an honoured process which grounded vision of life-long learning, both in terms of improving oneself and as part of their duties to the continuity and social fabric of their school community.

All the teachers talked about their practices in terms of their duties in the local moral order as a teacher, often in relation to serving the often complex expectations of their students. These teacher stories often narrated experiences within the broader curricular or
non-curricular culture of the school which occasioned learning in themselves, and which they clearly believed directly benefited the learning of their students.

**Social Orders of Action**

Harré (1993, 2002) argues social-action can be considered as organised by “an expressive social order” and “a practical social order”. An expressive social order is concerned with the organisation of status and honour. In this study, it is among teachers in the school and outside the school in the professional associations of physics teachers and the state examination authority. On the other hand, a practical social order is concerned with the maintenance and the organisation of work of physics teaching and teaching more generally in the school. The influence of these social orders, which rarely operate separately, was readily identified and continually revealed in the teachers’ stories of their agentive spaces and professional identity formation.

As discussed earlier, the findings illustrate that the teachers were inclined to talk through a generic lens. These broad self positioning accounts, or “rhetorical redescriptions” as Harré and van Langenhove (1999) characterise them, focused on social entities such as students, curricular concepts and pedagogical objects, which can be, related to general material causes in the social world of school education. Material entities, such as particular favourite apparatus, or media and activities occasioned by the teachers were considered as affordances in their teaching generally, and in physics teaching. The teachers’ descriptions of the operations of these affordances in their classroom practice were analysed within Harré’s practical and expressive social orders. The teachers’ location of their personal beliefs in generic storylines, associated with their broader recognition both in the school and beyond in physics education, indicates the priority given to the expressive social order over the practical, particularly amongst the experienced teachers, who had more of their identity invested in the historical and cultural status of physics as a subject in the secondary curriculum and engaged in a collaborative constitutive order in a shared project in the development of the curriculum of their school with other staff.

In their accounts of their practice, the teachers’ prioritised their expressive acts; for example the teachers spoke about how physics is perceived in their school, referencing the social order of honour and status over what they saw as acts of practice; for example
how the physics teaching is conducted, which reference the social order maintenance. When both the experienced and the younger teachers discussed their school as a community and their responsibility to it, there was a strong sense of a committed grammar often indexed by the use of singular or collective personal pronouns, “I” or “we” as discussed in the individual cases of the teachers in the previous two chapters.

The discursive positions the teachers took cannot be reduced to simple role taking or general rule following. The feeling of being a physics teacher they expressed can be seen in their accounts to emerge in Foucault’s terms as “knots of reason” or “technologies of the self” in areas of production of student learning, signing of good teaching, power in relation to their influences and efficacy and their self-esteem. Thus, the sense of belonging seems to play a role in the process of working out within one’s own technologies of the self. Hence, to consider a person’s technologies of the self could provide better understanding of their identity.

6.4 Summary of Findings

The findings are summarised under four common place dimensions of teachers’ reflection to point to similarities and differences among the teachers’ accounts. Simultaneously, the emergent themes are discussed and examined. For the purpose of easy referencing between the two groups of teachers, the superscript of X is put next to the experienced teachers’ names. The subscript of Y is for the early career and pre-service teachers. Hence, X identifies the eXperienced teacher and Y is for the Young early career and pre-service teachers. By using positioning theory as an analytical tool, I attempted to maintain a dual focus on the social-cultural context and the agency of the teacher in interpreting their discursive acts and actions.

6.4.1 Vision and Motivation

The teachers’ stories are seen to be in relation to their description of their perceptions of their daily activities and how they manage their classroom and students. Their stories will be seen to be mainly be aligned with their visions, as well as their motivation, in their intentions to become a teacher. Their motivations can be better understand in their accounts as features of their situation as physics teachers in their schools rather than as features of themselves.
The vision seems to arise as a result of social constructs from outside the school setting whereas, in contrast, the motivation was embedded, and arose from within what the teachers value and believe. That is, their motivation was intelligible to them in the teleoaffective structures of their practice (Schatzki, 2005), which appeared to be unchanged or transcendent throughout their career, but redefined in a change of school. This teleological structure of their practices could include many constituents: “their intentions, actions, emotions, and moods as well as the ends, purposes, projects and tasks” (Schatzki, 1996, p. 101).

What has been identified here, as their vision, was the intelligibility of their practice using Schatzki’s fourfold areas of practice: “practical understandings, rules, teleoaffective structures and general understandings” (Schatzki, 2002, p. 87). Their accounts of their visions tended to be emergent, aligned with an increased priority being given to the expressive social orders that is structures of attributing honour and status. For the teachers in this study, the expressive activities are seen through their visions and their motivations as a result of how they perceived their duties and responsibilities, specifically in their school settings, and as a community of physics teachers in general.

One interesting unique example in this study of a teacher’s private vision, that is structured by the expressive social orders, is seen with KateX. She placed great emphasis on presenting physics, as a desirable subject for the students to choose over the other subjects in her school. KateX’s vision here can be seen contextually in her construction of the duties of an experienced teacher in a school that has a reputation for attracting students from outside its catchment areas. She makes imaginative efforts to promote physics as an area of study in the junior years seen by students as a fun and interesting subject.

**Why I want to be a teacher?**

Specifically, teachers’ motivation was initially identified through questions I asked about why they became a teacher. All the teachers indicated they saw teaching as a rewarding and satisfying, and this is what motivated them to explore a teaching career. They also saw themselves entering teaching, already committed to a belief in the importance of physics as a form of basic scientific knowledge, and to teaching as a way to help students develop their understandings in physics. This was consistently stated by all the experienced teachers: NelsonX, WilliamX, KateX, NoahX and also by three of the early
career teachers: Mark\textsubscript{Y}, John\textsubscript{Y}, and Lisa\textsubscript{Y}. For some of the teachers, the teachers who had taught them during their student years had been role models and had contributed to their motivation to become a teacher. Both Nelson\textsuperscript{X} and Simony\textsubscript{Y} identified their previous role models.

Simony\textsubscript{Y} specifically termed teaching as a socially worthwhile profession, and this was recognised as such in everyday discourses with colleagues and significant others, in particular as stated by Nelson\textsuperscript{X}, William\textsuperscript{X}, Noah\textsuperscript{X}, John\textsubscript{Y} and Mark\textsubscript{Y}. Teaching was experienced as a vocation associated with a passion for always wanting to work with other teachers in a constitutive social order, that is an organisation structure that is both collaborative and future oriented where rules are emergent in shared projects; for instance of teaching physics in their school, rather than pre-set and applied at a distance. Kate\textsuperscript{X} presented a more individualist than communitarian motive. She viewed teaching as her job. She committed herself to leading her students into physics outside the classroom and school in the junior years. James\textsubscript{Y} and Maria\textsubscript{Y} declared that a “love for science” drew them to a career in teaching, after each had been in another work field. As early career teachers, they valued classroom teaching of prescribed curricula as contexts in which they could assess and improve their own physics understanding and science knowledge generally, filling in specific knowledge gaps in their formal education and broadening their employability in their schools.

Besides having their own interests and reasons to be in the teaching profession, and their interests in physics, the on-going motivation for all the teachers seemed to be embodied in continuous and positive social relations in schools, and this included relations with their students.

The teachers’ expressed visions for their physics teaching prioritised the usefulness of the big ideas of physics in the future lives and careers of their students over their training in the application of a number of algorithms necessity to excelling in examinations. The examination success of their students was nevertheless a key index of their own personal qualities as a teacher. Most of these teachers, and especially Nelson\textsuperscript{X} and William\textsuperscript{X}, spoke of projects in which they were exploring their own ongoing development as teachers, and contributing to the broadening and deepening of the educational experience of students in their school.
Again, it is clear that the teachers’ visions are driven by the practical intelligibility of their duties and responsibilities as a teacher, not only for their own development but more importantly for their students’ and schools’ development. Clearly, none of these teachers felt they arrived personally fully equipped for the agential spaces that their school or schools afforded. The social arrangements for creating honour and status, which constituted the expressive order in each school, were characterised differently, in terms of being or becoming a “good teacher” and by a commitment to all-round self-improvement in this direction. Sometimes, the teachers express themselves consciously in the ways they use their skills and through their attitudes, emotions, feelings, and so on, which enable others such as colleagues, ideally not only in their subject department or in their own students, to draw conclusions as to what kind of person the teacher is (Harré, 1993). In this expressive order, Foucault’s technologies of the self, operated to give these teachers a sense of feeling good about themselves in respectful relations with others through the exercise of their status and also power in the staffroom and classroom. Even for Maria who feels she has not been adequately supported by her school in her efforts towards self-improvement can still engage the technologies of the self to feel good about herself in the local expressive orders as a potential teacher.

**Students’ Learning and Success**

The teachers discussed their duties of social expectations and responsibilities or initiatives taken towards their students’ active participation, involvement and engagement in their lessons. My classroom observations of the teachers’ social behaviour in their physics classrooms, although comparatively limited in this study were never markedly inconsistent with the teachers’ conversational accounts of their own practice. Social order is maintained through the distribution of the rights and the duties to their students. Reciprocal innervation and response occurred more fluently in the classes of the experienced teachers.

In terms of the production of student success in examinations, it was Noah and Lisa who emphasised most strongly that students’ deeper learning shaped their teaching approaches. Interestingly, they are from the same school and Noah mentors Lisa. On the other hand, Kate pointed out the need for her, identified as her duty, to prepare her students for examination(s), as most of her students intended to have, and needed, physics for their future studies. She also commented on the extra effort required to strategically
equip her students to answer examination questions. Her experience working with the State examination panels, led Kate\textsuperscript{x} to observe that students’ answers to examination questions needed to meet what examiners expected of them. Thus, her senior physics teaching was more explicitly framed by the practical order of maintaining her school’s academic status and, at the same time, in her physics teaching she prioritised the expressive order of honouring physics, as a desirable subject of choice.

6.4.2 Practice and Understanding

In the storylines of experienced and inexperienced teachers, the challenging complexity of the social task of teaching is strongly expressed. Consistent with research reviewed earlier, the teachers’ accounts reference their feeling of insecurity of acting in the school with others in an inextricable tangle of moral and epistemological challenges, which while generally more acute among the beginning teachers, was articulated generally in influences on their choices of teaching approaches and the selection of pedagogies in different school contexts. Teachers saw themselves as responsible for the provision of an optimal learning environment most appropriate for learning and for the group of students that they teach. Yet, teachers were restrained by historically accessible resources, and by the specific local moral orders associated within their discursive circles of physics teaching, be it in habits of action, habits of interpretation and habits of belief, within which they must express themselves. In the light of this research, expression precedes experience. Again, the teachers’ repositioning and transformation of identity was particularly strongly expressed by beginning teachers and other teachers who had recently moved schools, where understanding and recognition of their duties and responsibilities in relation to practices that necessarily precede their choices and had to be reconstructed. The importance of having a “good relationship” with their students was often emphasised in sacred stories of good teaching but rarely characterised in secret stories of their teaching.

For the teachers, the practical orders of teaching in a particular setting, or school and physics teaching culture, extend to all sorts of projects and ends, that are taken to maintain professional life. The teachers discussed in terms of the duties expected of them which included managing students’ learning and recruiting them to disciplinary discourses in the senior years. For example, the practical social order which John\textsuperscript{y} discussed concerned the routine business of maintaining teaching and learning in his school environment. In
this practical order John_Y has his local “proper place” as a physics teacher maintaining students’ preparation for senior tertiary entrance examinations, as well as a teacher in other curriculum areas in the middle school. With his Year 12 class, John_Y performed to the dominant expectation of him that his students should perform strongly in the State wide competitive examinations. In the case of Maria_Y, the low efficacy she ascribes to herself is inscribed by weak disciplinary structures in her third school, communication difficulties with her English as Second Language (ESL) students, and the lack of material resources for science teaching.

In physics teaching, the other component of the social orders, that is the expressive order, is seen to honour fluency in explaining and demonstrating key abstract concepts of physics using physics equipment. By using these equipment that are clearly associated with physics along with the use of mathematical representations help to induct students into the cultural appreciation of physics through their teaching. For example, John_Y characterises his self-improvement in terms of broadening his contribution in extra-curricular duties, which serve another expressive order (Harré, 1993) in his school. Thus, for John_Y, his physics teaching is framed by the practical order of subject teaching and curricular maintenance whereas his contribution in the extra-curricular and technology coaching is guided by the expressive order of teaching in his school. These attribute him with a feeling of personal satisfaction as well as gaining an institutional recognition.

Another example of the expressive social order of honour and status is Maria_Y, who felt little honour or status was granted to her in her teaching which she sees as undeveloped in her third school, but still reasons her school has failed its own expressive order to provide her with the proper and adequate school support, in terms of mentoring and team teaching, that would signal respect and recognition. Another teacher, Mark_Y felt his honour and status rests with his students’ enjoyment in the doing of hands-on activities. His own performative understanding can successfully occasion learning in his students, by establishing situations that “call for” intellectually engaged responses in particular situations. Another teacher, Lisa_Y, occasions diagnostic testing to engage the reluctant or disengaged students in her classes, ascribing honour to herself in the expressive order of good teaching, while still attending to the maintenance of the practical social order (Harré, 1993) of her school.
School Support, Expectation and Teachers’ Commitments

The teachers’ general understandings of physics teaching that Schatzki (2010a) sees as influencing site-based practical intelligence seem to be associated with the teachers’ common goals or beliefs within their social community. General understandings hold the organisation of their practice together. This includes what it means “to be immersed in a tradition, in a social group with a ‘culture’ to it, seems to be” (Shotter, 2013, p. 133), a major issue that this research opens up. “Culture”, Heiskala (2011) observes has replaced the “social” as a totalising influence in sociological writing. The school’s significant role in a teacher’s development, in particular for beginning teachers, was apparent in this study, thus reinforcing findings discussed in the literature review (Beauchamp & Thomas, 2011; Flores & Day, 2006). In this study, the findings have significantly showed that, for each of the teachers, their school tradition or culture has influenced the kind of stories they shared as well as being emphasised in their accounts. This orientation aligns with the literature that indicates that a community of practice and school culture, as well as culture of any subject teaching shape a teacher’s practice (Beauchamp & Thomas, 2011; Bryan, 2012; Day & Gu, 2010; Mansour, 2009; Wenger, 1998). The time and space that these teachers inhabit, in their schools, strongly influences their understandings of physics teaching as a social practice and their agency in many ways (Caldwell, 2012; Schatzki, 2000, 2003).

The school site influences and shapes the tacit or explicit understanding of how a teacher can or should think and act. This directly relates to shared performative understandings of “how things get done here” and of the duties and responsibilities of these teachers, in their specific local moral order. Marky happily reflected that his small school is very supportive and flexible in supporting teachers’ decisions, with respect to how they chose to teach. The psychological significance of social acceptance in the normative discursive circles in the school, of their performative understanding, was a self-ascription common in all of the teachers, particularly in their early years in teaching but in any new school in which they taught. The social pressures to reposition themselves and their identities was particularly felt in Maria’s personal narrative, but was also strongly rejected by Nelson when he first came to his current school. Kate indicated that this sense of her practical intelligence, which could be seen as trust, was ascribed not only in conversations with colleagues in their science department, but also in different situations among students and
the parents. The absence of this forced repositioning in her current school in comparison with her previous schools made teaching in her current school easier.

Different schools serve different traditions and provides different contexts to the teachers and hence to their stories. Different social narratives of physics teaching may be expected to emerge in the teachers’ stories as a result of different school systems. Each social context was then characterised by a different local moral order of the schools. For the experienced teachers, the context is provided by a different sense of their moral integrity. For William\textsuperscript{X}, living in the here and now of a high status academic boys’ private school that produces outstanding success for their students in university entrance examinations and where students are expected to strive academically to do well saw support for this attainment, developed dialogically with them, to be the key horizon of cultural significance (Taylor, 1991). Similarly, Noah\textsuperscript{X}, who is involved in an official role in the assessment process in the state, found occasioning the excitement of physics as an academic field and the social application of this knowledge to be the key horizon of significance in his teaching. As well as by being recognised as a good physics teacher by his students, he supported a community of physics teachers in the State, volunteering for senior roles in the State Standing Committee responsible in particularly critical period of reform of the physics curriculum post PSSC eighties and the annual examinations in which William\textsuperscript{X} also enjoyed participation.

The differences in the school contexts point to commonplace reasoning about how the basic business of physics teaching is carried out in term of schools' priorities. This finding in relation to different situational, cultural and societal identities of the subjects imply that in preparing teachers in training, it is important to recognise the strong influence of the school in the social organisation of a teacher’s life through practices that precede their actions. These practices embody and embed each school’s norms and culture, notions of authentic learning and student-teacher relationships, local parent community expectations and even the socio-economic status ascribed to the student populations, and their teachers, in societal rhetoric. The teachers in private schools are shown to have freer access to professional development opportunities and curriculum enrichment opportunities for their students. Pre-professional disciplinary training in physics was expected and shared in staffrooms in the larger private schools in which William\textsuperscript{X} taught. Whereas for state school teachers, such as Nelson\textsuperscript{X} and Kate\textsuperscript{X}, their responsibilities were focused at a basic
level on retaining students in school in Nelson’s situation, and to open career option for their students. Hence, in state schools, the responsibilities required a broader focus, not solely to teach through physics towards access to technical professions in engineering, science or commerce, but continually in terms of occasioning educational encouragement and motivation.

William, Kate and Nelson in particular indicated that good teaching should involve getting support from a teacher’s social network, which provided positive affirmation for teachers, regardless of their years of experience. Nelson, who has been teaching both in state and private schools and also participated in writing the recently formulated National Physics Curriculum, expressed disappointment in the lack of a professional support network for physics teachers in Victoria, VicPhysics, which he saw as not as active and dynamic as it was when it was introduced. Through social networking, Nelson felt that discussions among often professionally isolated state school teachers could cooperatively constitute their own order of improved physics teaching in their own setting. The condition of physics teaching, as experienced by many teachers, is their professional isolation as physics teachers in their schools is highlighted in this study in the cases here of Maria and Mark. Nelson and William both argue the social need for schools to support physics teacher networks, particularly referencing for experienced teachers to share their wisdom.

Noah, John and Mark spoke of their sense of achievement and skill development in collaborative projects with colleagues outside their subject department in extra-curricular roles in their schools. For William, although he did not dwell on how his non-teaching roles had influenced his teaching, he did emphasise the power of such contextual, cultural and social dialogue outside his physics teaching practice, in his ongoing identity formation.

The horizons of significance, which the school provided, were essential references for each teacher for their sense of themselves. This includes the range of choices that are given to the teachers, the expectations on them in relation to their workloads and the tensions that they had to cope with. A sense of their common sense reasoning in relation to the expressive order of their school is revealed in each teacher’s self-positioning in relation to the school’s expectation that they should be capable and skilful. The normative reasons for action, feeling and thought that they were faced with were not as such
psychological properties of their desires or representations of themselves but aspects of the complex world of interaction with colleagues, students and pedagogical objects in their everyday social practice. Whilst some of the teachers did position themselves in an agential role with a constitutive sense of responsibility for maintaining and improving physics education through contributing to the design of the senior physics curriculum and its assessment, generally the normative reasons given for their actions were expressed in terms of their accountability to their students in their school which required them to work within the “rules” of the prescribed curriculum, but not just simply to follow it.

Most of the teachers presented cover type stories of the expressive order of their agency in the new design of the national curriculum where they indicated when it is implemented, they might have to change what they taught but they would not change how they taught. Their technologies of the self in production, signing, power and the self were evidenced in these stories. These processes were in many ways the focus of their discussions, rather than discussions on the influence of the practical order on their agential space. NelsonX indicated that although his current school expects teachers to follow certain rules and ways of teaching, he retains the rights and moral authority of his experience to teach the way his experience has taught him his best. He argued that although his approaches might take longer, he could occasion meaningful teaching and authentic learning for his students and at the same time prepare them successfully for examination. His habit of belief clearly had influenced his habit of meditative thinking. Nevertheless, NelsonX did point out that, as a beginning teacher, he would have engaged more in calculative thinking, instrumentally following institutional orders more closely.

Simony, a pre-service teacher, indicated his worries after he had attended just a few weeks of his teaching practicum. His observation of his mentor’s teaching approaches in the school, which were in his words “traditional”, made him think about whether he had the ability or commitment to work well in teams or with institutional norms if he had different expressive purposes.

A common vision in the teachers’ stories is of them producing good teaching and learning in the sense of Foucault’s technology of the self. This is often understood as their duty but more often as their responsibility as a teacher. For example, although KateX sought a broader student engagement in her physics teaching, and that her students should feel involved in their lessons, the development of key understandings was the end point. This
is her understanding of her students’ participatory responsibility. Similarly for Lisa_{Y}, she felt she ought to be actively and effectively delivering the teaching that was expected of her.

**Relationship with Students**

Personal teacher-student relationships were among the most often discussed by the teachers or implied in their shared stories. Among the things highlighted by all of the teachers, and emphasised by some more than others, who expressed whole-heartedness (that is the experienced teachers and Mark_{Y} and John_{Y}), is their need to build good personal relationships. This is expressed in a narrative of open, meaningful reflective, classroom conversations with their students, in which the students are freed to learn not only what the teacher knew of the big ideas of physics but how they knew them and how they valued these ideas.

Noah^{X} pointed out that having a good relationship with his students needed to be distinguished from emotional “caring”, associated with their well being. Caring, for him, was focused on taking seriously students’ learning intention and, in this sense, making lessons more interesting, challenging and hence enjoyable. All the teachers indicated they aimed to produce enjoyable and fun lessons for the students and themselves. Noah^{X} and Mark_{Y}, directed the focus of discussion away from the notion of the authentic individual physics teacher as somehow operating with their students in isolation from the real world and placed themselves in it instead on the quality of his or her relationship to everyone in the school. This view seemed to indicate a sense of being beyond the disciplinary discourse of a physics teacher, to include the conversational realities of students and other sciences teachers, the educational culture of the school, and at large in society.

The importance of understanding students’ individual needs was discussed by the teachers in terms of their responsibilities to their students. The respondents felt teachers should make themselves readily available to their students, even outside the physics classroom. Interestingly, when discussing the importance of understanding and allocating time to the individual needs of their students, only William^{X}, John_{Y} and Mark_{Y} gave specific examples related to named students. John_{Y} pointed out how he now understands much better, after experiencing a lesson with a special needs student in his class, that
“differentiated learning” is needed in order to accommodate the differences among his students as his responsibility rather than a vague duty or expectation.

To better understand students’ learning difficulties, the significance of student feedback was often highlighted. WilliamX, JohnY, MarkY and LisaY emphasised the importance of occasioning affective as well as cognitive feedback. As WilliamX observed that classroom feedback helped him to understand his students, and hence shape his lessons to suit his students’ needs.

**Concerns about Students**

All the teachers did talk about managing students’ behaviour and learning dispositions. MariaY constantly discussed this. In her urban state school, MariaY pointed out her dissatisfaction with her students’ lack of motivation to learn and behave appropriately in the school. She felt this was a result of the failure of the school administration to enact disciplinary policy. In addition, she felt this was worsened by having students with English as Second Language (ESL) in her class. On the other hand, KateX did not experience such motivational problems although she had ESL students in her class. WilliamX, NoahX, MarkY and LisaY did not identify or discuss any problems with student motivation in their classes in well-resourced private schools.

**Curriculum Structures**

The teachers, except for KateX, did not discuss concerns over things related to the Victorian education system per se. KateX shared her worries about the mismatch between how the course handbook described the course and as to how the examination is actually assessed. This led to her worries with the new Australian National Curriculum, where the assessment would still face the same issue. KateX was still battling structures, seeking greater conformity between the vision statements of the curriculum and the assessment procedures. However, she also claimed that regardless of how the curriculum is structured, her own ways of teaching her classes still work for her and her students. These restrictions she felt were not those commonly identified by progressive reformers. That is the concerns with the lack of opportunity to make their physics teaching relevant in the day to day existence of their students through classroom discussion of science and society issues surrounding the presentation of physics ideas in the public media.
On the other hand, Nelson\textsuperscript{X} and William\textsuperscript{X}, although they indicated some concerns over the large scope of the new National Curriculum with its focus on the ideas of physics in action in society, did not indicate this was a problem. Their confidence in the context of being a teacher resided in the authority of their experience embodied and embedded in their practice. They knew what they were doing and could do it in the classroom in their school; what they did was well regarded by significant others in everyday discourse. They felt they took the prescribed curriculum to be a guide, rather than a “rule” to follow. As discussed earlier, all the four experienced teachers have had various roles in Victorian Curriculum and Assessment Authority (VCAA) such as examiner, assessor and course writer. Interestingly, it was William\textsuperscript{X} and Nelson\textsuperscript{X} who, without being prompted, discussed the importance of having knowledge of the social history and the philosophy of physics for physics teachers. Having these knowledge, allowed both of them to present stronger cultural and moral claims for their social agency in their teaching. Noah\textsuperscript{X} and Kate\textsuperscript{X} did not directly reference any historical or philosophy of science issues in their physics teaching neither did the other six early career and pre-service teachers.

Curricula History

Only William\textsuperscript{X} and Nelson\textsuperscript{X} discussed past State physics curricula, and their influence on their early physics teaching careers. They talked about the implementation of the Physical Science Study Committee (PSSC) physics course with its heuristic emphasis during their own student time, and early years of their teaching careers, as a significant professional cultural and individual influence.

William\textsuperscript{X} pointed out how he wished to see more experiments in physics curricula like the ones in the Nuffield curriculum, as well as the Extended Practical Investigation (EPI), that used to be in the curriculum. For William\textsuperscript{X} and Nelson\textsuperscript{X}, their involvement in curriculum writing have convinced them of the need for physics teachers to have knowledge about the social history and philosophy of physics. On the other hand, Kate\textsuperscript{X} and Noah\textsuperscript{X} in different ways were more involved with the assessment and accountability, and did not specifically discuss about changing foci of the physics curriculum policy.

Only William\textsuperscript{X} and Nelson\textsuperscript{X} discussed the impending Australian National Curriculum. None of the other teachers in this study, even after prompting, talked about the content of the new curriculum in relation to the current curriculum except for Kate\textsuperscript{X} who pointed out
her dissatisfaction with the likely perpetuation of established assessment procedures. William\textsuperscript{X}'s and Nelson\textsuperscript{X}'s identities, on the State Committees, outside their own school sites, underpin their identities as capable physics teachers in various discursive circles including those in their schools.

Kate\textsuperscript{X} alone raised her concern about the declining number of students choosing physics. From the perspective of the others, any unattractiveness of physics, compared with other subjects, was discursively associated with its greater rigorous abstraction, rather than a reflection of their professional failure as teachers. Maria\textsubscript{Y}, because the number of students doing physics in her school is small, had a physics class that combined Year 11 and Year 12 students. This was challenging in terms of preparing her lessons to satisfy mandated curriculum requirements as well as to accommodate her students’ differing academic needs and outlooks.

**View about Physics, Physics Teaching and Related-Issues**

While generally, the teachers did not speak directly their views about physics and physics teaching per se, except when they were prompted. Nelson\textsuperscript{X} and William\textsuperscript{X} discussed their views about the significance of physics content knowledge. In unprompted discussion, the other teachers presented cover stories only in which the problems of getting students’ interest in learning physics, or how they teach differently in physics were accounts from within the unchanging objective culture of the prescribed curriculum. They described physics teaching as being concerned with the basic scientific knowledge, which explains all natural phenomena. This is a point of honour in the social order that physics knowledge is more fundamental than others. This is also the tacit reality of their acting within the culture of the school, and society at large, and indicates how the physics of the physicists is, and should be understood and appreciated by physics teachers as well as the broader community. This orientation relates the teachers to the material and social circumstances of physics teaching “in terms of what we think they must be [like], rather than in terms of what actually they are” (Shotter, 2013, p. 151).

William\textsuperscript{X} said in physics teaching he was always concerned with basic or systematic causes of material phenomena, while teachers in the other sciences were offering students only more detailed descriptions of the material phenomena. Lisa\textsubscript{Y}, on the other hand, who teaches both physics and biology, discussed the differences between her teaching in these
two subjects in producing learning, not in relation to their contents but in relation to her students’ academic abilities.

Four of the teachers, WilliamX, NelsonX, NoahX and Mariay described physics in relation to mathematics. These teachers saw mathematics is essential in explaining physics to their students. However, NelsonX emphasised that mathematical algorithms do not assist students to gain conceptual understanding of the ideas in physics. NoahX indicated how physics provides more variety of interesting activities for students than other school subjects. An emphasis on mathematics reasoning was thus seen by both as having a limited benefit for physics explanations. However, examination items often probed students’ algorithmic or mathematical reasoning and to test their students’ understanding of physics. This was a point that KateX made.

When the teachers in this study discussed their physics teaching with me, their different approaches to teaching become apparent. Teachers’ styles of explanations show differences in terms of how teachers make different assumptions about the prime function of explanation, in representing a scientific “reality” or responding to others’ “construction” (Ogborn, Kress, Martins, & McGillicuddy, 1996; Roberts, 1996). Johny, for example suggested that his students constructs and reconstructs their understandings through whole classroom conversations, as well as conversations between students and via conversations between him and his individual students’ conversations. He seemed to indicate that his explanations “occasioned” the collecting and reshaping of ideas together from the class discussion, rather than literally those imposed on students, or it was left to students to construct their own understanding of a phenomenon observed in class (Ogborn et al., 1996). This opened up opportunities for more discussion among his students and working towards getting the right ideas and concepts. Jamesy, on the other hand, proposed that understanding the ideas of physics can only occur by letting students do activities that invoke or occasion experiences which relate to their own real life situation. Although, the nature of James’ explanations in physics are underdeveloped and “activity” in physics teaching is a popular cover story, it should be noted that I had only two meetings with Jamesy in which to explore his notion of how “activity” worked in his classes.

For NelsonX and NoahX, they held curriculum leadership roles early in their teaching years, which they perceived, required them to better articulate and understand and improve their own practices. NelsonX recalled his leadership roles led him to read
materials on constructivist teaching which then supported him to teach constructively. Similarly with Noah\textsuperscript{X}, his early role in the State Standing Committee required him to understand essential tensions between prescribed and constructed meanings which had assisted him to develop his practice. These teachers’ appointments to such senior positions and responsibilities are seen as important in the development of their physics teaching, both for their schools as well as wider community of physics teachers. For both Nelson\textsuperscript{X} and Noah\textsuperscript{X}, teaching physics served an essential purpose in presenting physics as knowledge that objectivises understanding the real world, and is a knowledge publicly recognised as essential to the reproduction of a technical class in society. Their explanations were of both in “say it my way” mode, a way that specifically assumes the representational value of language; as well as in the “see it my way” mode, in which teachers’ explanations enforce a specific vision of the world that helps students to see phenomenon (Ogborn et al., 1996); for example by demonstrations or practicals, in order for their teaching aims to be beyond just a mere transaction of knowledge.

Concerns about the current changes in the direction of physics education were only explicated by Nelson\textsuperscript{X} and Kate\textsuperscript{X}. However, it is not clear if their concerns arose from either their own biographies, their own experiences in their own classrooms, in the site-based ontologies of the practices in their schools or influences in their pre-service training. Nelson\textsuperscript{X} worries when many students think physics is too difficult to even attempt. Kate\textsuperscript{X} worries when students tend to think doing physics requires an ability to solve problems from textbooks. Nelson\textsuperscript{X} argued his habit of belief influence how he interprets students’ attitudes, which then influences his habits of teaching unless seriously contradicted in practice.

Logistical issues inhibit teachers’ choices particularly in the early years. For early career teachers, the idea of doing serious physics thinking outside classrooms in particular, going on excursions or managing a practical, pose major problems. They found that organising and coordinating excursions required extra time, not provided by the school, to prepare, although the activities were, they believed, often were the key to engaging their students. Maria\textsubscript{Y} and John\textsubscript{Y}, who indicated that they have done excursions, would want to plan more trips in the future, in the cause of becoming better teachers, if they had extra time to plan, prepare and to actually do it. For the other teachers, this was not raised as a concern or commitment.
**Teacher Training**

All the experienced teachers were critical of their training programmes. They felt they were poorly prepared for managing classroom settings. This was strongly argued by Noah\(\textsuperscript{X}\), although he felt knowledge of classroom management has been improved within the structure of current programmes which are more school based. John\(\textsuperscript{Y}\) felt that theories he was taught in his teacher training had not and could not fully equip him for actual teaching but pointed out that teachers should expect to be able to adapt these theories within own school contexts. Nelson\(\textsuperscript{X}\) was the only teacher who argued for a stronger preparation in the history and philosophy of science/physics. In his own experience, this knowledge was essential in helping him to assess his own teaching. William\(\textsuperscript{X}\) advocated better philosophical preparation but of a broader nature than that emphasised by Nelson\(\textsuperscript{X}\).

**Teachers’ Key Reflection**

All the teachers shared their stories reflexively in relation to their works and their visions. Their reflections were often directed to, and in relation to, their teaching and their students’ learning, broadly in terms of their duties and responsibilities as a teacher. John\(\textsuperscript{Y}\) and Mark\(\textsuperscript{Y}\) were strongly reflexive in specific discourse positioning, compared to Noah\(\textsuperscript{X}\) and Kate\(\textsuperscript{X}\) who offered broader rhetorical re descriptions of their physics teaching but no teacher saw presented their identity as complete. John\(\textsuperscript{Y}\) and Mark\(\textsuperscript{Y}\) continuously discussed the processes by which they were striving to improve their teaching. William\(\textsuperscript{X}\), Nelson\(\textsuperscript{X}\), Mark\(\textsuperscript{Y}\) and John\(\textsuperscript{Y}\), all emphasised the importance of life-long learning in teaching, and effort that they felt they had to make to learn from others. James\(\textsuperscript{Y}\) seems to have made a similar commitment to securing his future in physics teaching. Noah\(\textsuperscript{X}\) and Kate\(\textsuperscript{X}\) more than the others positioned themselves as possessing the practical knowledge required to deal with any issues they faced but in different ways.

**6.5 The Participants**

**6.5.1 Early Career and Pre-Service Teachers**

From my conversations with the early career and pre-service teachers, their focus and priority were consistently focused on their current practices and ways to monitor them as to improve their teaching. This was reflected through their discussions in relation to their duties in the schools. These teachers referenced their feelings on being insecure, in particular concerning the quality of their school’s support and mentoring. School support
and mentoring were both discussed by these teachers as well as by the experienced teachers; a reflection of the increasing complexity of the teacher’s role generally in schools at all stages of their career. Their comments indicated the importance of the sense of discursive community, in which psychological positioning, institutional practices and societal rhetoric can be explored particularly by beginning inexperienced teachers.

Three out of four of the early-career teachers, except Lisa, were mature-aged entrants who came to teaching as a second career. They felt they had brought different professional understandings, experiences and often generational identities, compared to their colleagues, in schools. This was valuable to them personally as teachers, and to the school, at different times and ways. These experiences informed the construction of their teaching identity. John, who had previously worked in Information Technology (IT) consultancy, had been actively involved in non-teaching tasks, such as helping other teachers in his school with the use of information technology. With the advantage of possessing the technology expertise, John had put his physics-teaching persona in the practical order of the school and had gained respect from his colleagues due to this. Consequently, it was through his IT persona and his successful contribution to the professional learning of his colleagues in the wider social fabric of the school that he felt he enjoyed agential status in the expressive order.

Likewise, James perceived that his previous work experience had provided him with an advantage when compared with his other peers in the teacher training course, especially in terms of personal time management, social communication and interpersonal skills. Nevertheless, both the pre-service teachers, James and Simon, were more inclined to relate their success stories to what they had learned in their teacher training courses. Perhaps with only teaching-attachment experiences, these two teachers tended to talk more about their experiences during their teacher training, their own student years in schools, as well as their discussions with others.

In terms of conducting discussions with others, these novice teachers discussed not only with people in their own school community but also with people whom they met in the few conferences they had attended outside their school environment. As John was teaching more than one subject, he found it difficult to decide which specific subject area he should focus on when it came to choosing a conference to attend. Mark indicated that besides attending professional development sessions, his monthly attendance at the
reading group meeting with the science people from the other schools as well as people from the university, had helped him to develop as a teacher based on his experience, understanding and knowledge about physics teaching and thereby expanding his view of his own agency and different structures or possibilities.

LisaY described the knowledge she had gained in her teacher training, particularly on how to create different kinds of questions to ask students, had been extremely useful to her everyday teaching. Furthermore, although she regarded her first school teaching experience as hard due to the minimum guidance from the school, the teacher training programme had continuously challenged and encouraged her to learn in improving her teaching. She also discussed in detail her experience of attending a conference and learning from the other participating teachers. The mentoring and professional learning sessions organised by her school had also provided good teaching experiences and resources. A mentoring programme for beginning teachers was also strongly discussed by the experienced teacher, NoahX, who claimed experienced teachers could help other teachers. NelsonX, on the other hand, indicated his worry about mentoring relationships in schools, where the mentor and mentee might have different objectives and understanding. Perhaps for the same reason, NelsonX and WilliamX opted for a team-teaching model of support, which MariaY wished she could have an access to.

As for the early career teachers, important experiences had emerged for them in attending conferences and their active involvement with non-teaching tasks. These experiences had assisted them better to achieve a sense of membership in their community and be perceived as one of their self-improving rights and responsibilities in their school. These teachers were in the process of developing their professional characteristics, identity and agency through a sense of belonging. This sense of being and belonging is one of the key aspects that helped in shaping the teachers’ agency and identity, as discussed in the research literature (Beauchamp & Thomas, 2011). The sense of being directs the focus of research discussion in teacher education, and brings us up against the nature of the world and the character of authentic learning.

**6.5.2 Experienced Teachers**

I expected the experienced teachers as experts who would share more personal stories than the early career teachers. Their reflections were drawn from a wide range of sources
and professional experiences. They were more able to articulate influences in their stories and were able to relate their discussions to their agential development. This aligns with the literature and the assumption at the start of this study, that experienced teachers should be more able to talk about their works and describe more affordances in their accounts of their occasioning of student learning. However, many of their initial examples were well worn cover stories. Later accounts of their practices revealed more sacred stories.

The experienced teachers seem to indicate that their practices were located in their contemporary agency. This was expressed in the form of their “will” to do the right thing that had to be done in their teaching, both as their duty and for their students, as well as for education as a whole; not simply to make “good” choices. Their cultural sense of duty embedded and embodied in a tacitly known real world of practice preceded any of their actions as a teacher and provided the horizons of significance for the teachers to have of themselves. This meditative “because” thinking or motive seemed to reveal larger and stronger prospective meaning than the calculative “in order to” thinking or motive which values the teachers’ own projects.

The experienced teachers reflected upon the community where they worked more than the early career teachers. Most of the experienced teachers in this study, who were regarded as expert physics teacher practitioners by their fellows, had sought to transcend these social orders through participation in state physics curriculum and assessment committees and professional associations that served both extended self-improvement and the improvement of policies that influenced the quality of education of their students. Their involvement with the design of reviews, curriculum documents, and textbook writing, as well as duties on examination or on assessment committees, or holding leadership roles within their own schools, appeared to greatly influence their perceptions of their authentic identity and perceptions of their effectiveness and overall confidence in their teaching.

There are some aspects, which were surprisingly not explicitly articulated by all of these experienced teachers. As discussed earlier, the prospective Australian National Curriculum and the historical and philosophical aspects of physics and education, were discussed by two of the teachers, William and Nelson. However, the philosophical and historical aspects of physics were not discussed by Kate and Noah, nor by all the other
early career teachers, perhaps because they did not see the roles of these aspects of knowledge in their practice.

In terms of on-going professional learning, both Nelson\textsuperscript{X} and William\textsuperscript{X} pointed out the need to be selective; to access only those professional learning opportunities that provide powerful ideas and from known “good people”, and for teachers to then be able to adapt the ideas to their own teaching settings. Kate\textsuperscript{X} said she was not happy to attend professional learning sessions organised in her school, which she said were not relevant to her teaching. She expressed a strong held point of view which she consistently emphasised throughout her interviews, that physics ideas constituted horizons of significance that she could introduce best through outside activities as to promote interest to junior students as well as and to promote broader engagement in physics at the senior level.

6.6 Summary

The phenomenological and social ontological dimensions of teacher practice were explored through the conversational interviews in this study. In their narrative accounts, the teachers’ identities as physics teachers were shown as active agents to be dynamic and changing in their own lives (Davies & Harré, 1990). These are not simply accounts of the static role of the secondary school physics teachers. This study examined the teachers’ positioning in their accounts of their everyday discursive practices which complemented their accounts of their role as a physics teacher and as they see it defined in their schools and society. In an effort to categorise these teachers according to the elements that informed their daily discursive practices, it was found that these teachers discussed what was intelligible in their own teaching in relation to their responsibilities and their duties. Their conversations seemed to flow and were framed and organised through significant events and aligned with their lives, own character and moral dilemmas (Davies & Harré, 1990). The teachers’ storylines of self, developed dialogically and were impacted upon and influenced by the teachers’ current institutional settings. The teachers’ pronoun grammar indexed the “oughtness” and “feltness” in their accounts of the strong teleoaffective structuring of their teaching (Davies & Harré, 1990; Linehan & McCarthy, 2000; Schatzki, 2005, 2010b; Sullivan & McCarthy, 2004). The sense of “oughtness” provides their senses to what they perceived as right and should be within their
community. Furthermore, the fine grained analysis of the teachers lived experiences enables an exploration of the impact of the teachers’ local moral order on their identity formation and active choices in their daily discursive practices (Linehan & McCarthy, 2000; Reckwitz, 2012; Sullivan & McCarthy, 2004). The analysis provides better understanding of the processes involved with respect to the teachers’ local moral order on their identity formation within their community of practice.

In this study, NelsonX, WilliamX, MarkY and JohnY discussed their purposes, reflected on, and selectively defended their practices, which they believed occasioned students’ learning that involved the exercise of reciprocal responsibilities and duties. The accounts of NoahX, KateX, LisaY and Mariay’s had emphasised on students’ duties of engagement and participation in their learning. A common and regularly discussed topic was their students’ varied needs, and how their students’ needs, as they perceived them, influenced their choices and approaches in their teaching. Furthermore, the teachers' perceptions of their authentic selves as physics teachers were embedded in horizons of significance which deals with rules and norms in their community of practice that demonstrated the traditions and social notions, as in this study, of good life of physics teaching (Bonnert & Cuypers, 2003; Taylor, 1991). These rules and norms, in the teachers' mental lives lived in a space of moral reason rather than causes (Brinkmann, 2006), necessarily bringing conflicting conceptions of the formal curriculum.

One insight that emerged in this study of the teachers’ accounts of their practices was the compulsion of the school culture that could affect “the will” for the teachers to do the right thing through their duties and accepting responsibilities, rather than simply making “good” choices in the more pragmatic sense. In addition to what the teachers had described what they did, they clearly described their understanding of their duties in terms of a reality that they believed predated their actions and what they thought was imposed upon them in the concrete social context of teaching in general, and physics teaching in their specific settings. These teachers further discussed how they had to learn by positioning and repositioning in their own settings by means of acting in socially accepted ways through technologies of the self in order to acquire or assume social recognition and a sense of self satisfaction and fulfilment.

The teachers discussed and highlighted events and key issues, which they regarded as significant, and of importance and valuable to them. I was interested in how they made,
or are made to make choices in their own teaching world. In terms of their physics teaching, the teachers discussed how they make practical sense of what physics teaching was in their own classroom, for their students and, at the same time, how physics teaching had already been operating in the schools. In other words, the teachers were discussing the practical intelligibility of physics teaching. That is, the teachers were describing their agential space as a site-based social ontology. Hence, the influences on their agency are in and from their everyday activities. These include what they have come to understand and feel about their duties as a teacher and to their students including their students’ rights, responsibilities and duties.

The teachers, whose stories showed their commitment and great interest in their work as a physics teacher, were more willing to share further their sacred stories. This is a rare level of personal and “subjective”, as opposed to “objective”, accounting supported by a large number of interviews and cultural familiarity. This was seen in particular when teachers in relation to their stories were more reflective and open-minded in the sense of embracing their own and others’ biases, and declared their commitment to projects in order to act for a purposeful change which would benefit not only themselves, but also the students, or the community at large. These teachers showed their understanding of the local moral order through their habits of practice of their responsibilities and duties. I observed that when teachers were discursively more focused on performing their duties to their students than their duties to schools in general, their sense of agency was stronger. This observation is supported by other researchers (Day, 2000; Day & Gu, 2010), who had argued from discussions with teachers that their commitment could be enhanced or diminished by factors such as student behaviour, support from colleagues and school, parental demands and educational policies.

In the conversations, a greater self-cultivated expression of communal powers defines a sense of authentic self, and agency, in interpreting the social orders to allow themselves and other physics teachers to do what they thought was right in their classrooms. Harvey’s (2002) critical realist analysis of community and agency employs Simmel’s notion of self-cultivation that explains the dependence but not determination of human agency on an environment of pre-existing cultural influences for its progressive self-unfolding. In Simmel’s self-cultivation, people advance toward some, yet unrealised aspect of their
humanity and through this, they appropriate a specific culture’s various values, structures and forms, which in this case of physics teaching, and also remould them.

I saw it as critically important to understand that, especially when thinking about the implications of this study, that although experiences in life play a role in how the teachers are willing to discuss and reflect upon their work, it is also the teachers’ ability to understand what their values and beliefs are, within their own context, and which originate from what they perceive are their duties and responsibilities, which is of significance. In order to inform and reform teacher training and school practices, this study supports the need to understand teachers’ personae and agency in the social contexts in which their identities are formed (Volkmann & Anderson, 1998).

In my effort to better understand the identity formation processes of a physics teacher, teachers’ self and other positioning in their stories and their storylines have assisted me to locate these teachers with respect to Shulman and Shulman’s four dimensions of individual reflection: vision, motivation, understanding and practice. I acknowledge that an emphasis on extended reflexivity alone is unlikely to transform the habitus of physics teaching in a school and an emphasis on understanding that habitus, as determining, is likely to diminish or deny the possibilities for teacher agency. A neo-Bourdieuian’s (1977) concept of habitus that he sees as fundamentally an embodied phenomenon, can usefully signify how we think about physics teaching as well as the “system of dispositions” that teachers bring to a field. For any teacher who enters a community of a school, which has its existing social conditions and cultural horizons of significance, he or she will need to share and act according to those authoritative principles, rules, values and norms or conditions. Wittgenstein (1981) personalises this observation of the teachers’ construction of the intelligibility of physics teaching, “what determines our judgment, our concepts and reactions, is not what one man is doing now, an individual action, but the whole hurly-burly of human actions, the background against which we see an action” (Wittgenstein, 1981, no. 567 cited in Shotter, 2013, p. 133). An individual teacher’s social identity and motivation are explored in this study as features of their cultural situation and their school tenure as well as features of themselves where their mental life is lived in the space of reasons (Brinkmann, 2006). In other words, the teachers' mental lives are constituted by normative rather than causal connections. The teachers' narratives of their motivation is embedded or realised in social practices.
Narrative research using positioning theory, that proposes identity formation is continuously taking place in social practices, is shown to be potentially much better suited to explaining processes of continuity and change.
Chapter 7 Conclusion and Implications of the Study

7.1 This Phenomenological Research

The research was not intended to be naïve reporting either from the researcher or the teachers. The rigour and trustworthiness of the research relates to credibility and transparency. I tried to write in an open dialogical form, that hopefully permits judgments of rigour or applicability and trustworthiness. The long running threat to a realist reading of the knowledge and agency of the teachers with different experience in this study is the idea that their perception is, at bottom line, subjective. But how can I assume, or how can it be known, that there is not a common world which I, as a teacher educator/researcher, can rigorously explore with these teachers and interpret in this research? I have, however, at times often doubted my capacity to make their perspective visible in this research. The research offers a positive demonstration of the psychological plausibility of the common sense view that there is a common world and that, in education, we jointly with colleagues and students explore it in our practice.

This study can be seen to be an existential consideration of becoming and being a physics teacher (Vandenberg, 1991). It can also be seen as offering a critical view of the rational extended reflexivity thesis (Adams, 2006) which remains popular in teacher education in universities and professional development in schools. Adams (2003) argues that “some level of ‘real’ reflexivity is itself evoked in being able to ‘see through’ existing accounts of others’ reflexivity. [But] from what position is one uncovering this oversight? There is a danger of endless regression” (p. 236). Adams suggests “that culture provides limits of reflexivity [or the intelligibility of physics teaching to the teachers studied] (Adams, 2003, p. 237). This study describes, in agreement with Adams “alternative discourses in [the] contemporary culture [that] provide alternative understandings of [physics teacher] reflexivity, which are less fashioned on rationality and reason, and [often] even acknowledge their cultural situatedness” (p. 237). As can be seen in this study, the teachers’ reflexivity is as Adams suggests, “is never a complete process surveying all before it, it is always based on certain cultural frameworks which allow it to interrogate itself in some ways but accept others” (2003, p. 237).

One of the common critiques of interpretive research is its little utilisation such as that of phenomenology in terms of getting a generalisation of a research outcome (Garrick,
Garrick (1999) argues by paraphrasing Heidegger that “the more important question is not: Can something be done with phenomenology? Rather, we should wonder: Can phenomenology, if we concern ourselves deeply with it, do something with us?” (Garrick, 1999, p. 147). In this study, the interpretive methodology used is a combination of social phenomenology (Heiskala, 2011) and discursive psychology (Harré, 1993). It assumes that it can do something with the teacher-researcher and former students asking questions such as: How have the teachers lived through the experience of teaching physics? And how these lived experiences has developed into authentic learning? (Garrick, 1999). According to Garrick (1999), individual stories are influenced temporally and contextually which requires the writer of the phenomenological text to unpack the stories in order to capture “the dialectical interaction of the context and the individual” (Garrick, 1999, p. 154) in becoming reflexive.

On the objectivist account every perception of the teachers or researcher in this research is a kind of judgment. But after Harré, I take perception to be a practice, understandable as a temporal, site-based ontology, a conversational exploration with the teachers of the transformation of their habits or social agency as physics teachers, through their accounts, aided by documentary extracts from their work of their direct and indirect experience and the intelligibility of physics teaching. From this dialogical platform I have sought both their ontologically secure inductions in their doings and sayings that extended the compass of their reality, their habitus, in all sorts of directions and a clearer description of the educational practices of a secondary physics teacher. I seek to explore their habits of belief and interpretation over the whole study of each subject's account, over a number of conversational interviews. Their participation is seen to be organised by the practical and expressive social orders, (Harré, 1993) of maintenance and honour in secondary physics teaching.

Tiberghien et al. (1998) indicated that the presentation of research results in science education tends to be in a raw form where the transfer to, and the meaning of, the results in the everyday social contexts of past, current or future practice are not necessarily straightforward. Tiberghien et al. suggested that discussion among teacher educators and researchers is essential in order to make link between research and practice. They suggested an establishment of an Internet site as one of the tools to improve physics education. They argue that the technology could enable for group discussion that might
lead to exchanging thoughts, ideas and practices in physics education as well as
discussion on results found in research that can be taken into own context. However,
research often loses sight of the local moral order of school and the person of the teacher,
and thereby their agential spaces are neglected or misunderstood.

This study suggests that we should be examining the ambit of Tiberghien’s discussions
about the transfer of meaning in science education research, between teacher educators
and researchers, to include teachers’ stories specifically of the intelligibility of their
practice, their agential space and identity formation. The dialogically constructed site-
based ontological accounts in this study provide case study material for such discussions.
This study recommends that, by examining teachers’ practices through their habits of
action, interpretation and beliefs, including warranted beliefs, and specifically the
tensions between them, a better description of psychological recognition may be achieved
with participants in such discussions.

Shulman (1991) and Tripp (1994) claim understanding of our purposeful past is often
important to our growth in that we have to consider not only the social and material
conditions of our practice either as teacher educators, researchers or teachers, but also
who we are, personally and institutionally, in one another’s life space. An investigation
of a life is necessarily the investigation of moral contexts and intentional actions. The
movement from receiving “good” advice in various discursive circles in which teachers
move, to their committed grammar discussion is an ontological process that should be
studied for the insights it can provide into the constitutive social orders through which
practice is organised and moral capacity and authority is pursued.

I concur with Wittgenstein (1958), Harré (2009) and Shotter (2011a) who argue that
“rather than using theory [whether of physics or education] ‘as a preconceived idea to
133), [a notion] which leads us into trying to live in our theories; [we as teachers or teacher
educator/researchers] need to learn is to live alongside them” (Shotter, 2013, p. 133). That
is as Shotter elaborates the ability to apply theory “as ‘objects of comparison’ in guiding
us towards being responsive to crucial features in our surroundings that we, [in reflection
on or in practice as teachers or researchers] might otherwise miss” (Shotter, 2013, p. 133).
For example, the performance of a demonstration in a physics class cannot logically be
taken to provide a proof of a theory, it is at best, Wittgenstein and Harré argue, an
invitation to a discussion. Often, as Tiberghien implies, what it is like to be immersed in a tradition such as physics teaching, in a social group with a “culture” to it, is perceived by practitioners to be misunderstood by outsiders. From a teacher educator/researcher standpoint, the “cultural change” or reflexive positioning that is daily called for among physics teachers appears to be met by the “business as usual” practitioner imperative. As outsiders, Shotter (2013) points out our misunderstanding in terms of what we know is “acting from within a culture” (p. 133) is like. In our research and teacher education roles, do we overlook the everyday discursive practices as to how teachers come to a normative “expression of their own inner sensings and feelings” (Shotter, 2013, p. 133) of their moral duties and responsibilities and intentional actions? Indeed we make an effort to better understand what needs to be taken into account in personal and professional identity formation of teachers. This can lead us in our “research collaborations” with practitioners where Shotter (2013) indicates that can lead to the assumption “that we can start our inquiries by [designing objective instruments or codes] reflecting, intellectually, on events occurring immediately around us, which then (mis)leads us also into thinking that we can orient or relate ourselves to our circumstances in terms of what we think they must be like, rather than in terms of what actually they are (Shotter, 2013, p. 133).

I asked what personal understandings and social meanings the teacher subjects in this study attribute to their practice as a physics teacher? How do they locate themselves in their accounts of their practice, in relation to the norms of senior physics teaching and, more generally teaching in their schools and beyond? How do they describe the processes which have contributed to their professional identity formation as physics teachers? The teachers’ self and other positioning took place in our conversations within the context of their specific moral order, as a physics teacher in a secondary school in the state of Victoria, Australia in which they were employed, to an obvious cultural outsider, a young female physics educator wearing a headscarf, embedded in an Islamic cultural tradition.

The teachers spoke autobiographically of their roles as a physics teacher, with its educational commitments and challenges, that they felt were generally shared, but with personal interpretations warranted by the authority of their experience. Their thinking was not mental activity so much as the activity of operating with signs of “good” physics teaching skills. Good student results in examinations were a powerful sign, if not a defining sign, expressing their standing as a physics teacher and were experienced as the
defining social expectation. Moral orders, of intentional action in maintenance and honour, structure their discursive and non-discursive practices. It is through these that their social relations and psychological position, with their students, colleagues as persons and things, such as the curriculum and their teaching strategies in various normative discursive circles, “are regulated and by which social norms or standards are […] promulgated” (Harré, 1984 cited by Tan & Moghaddam, 1995, p. 393). It is shown here that the teachers’ reflexive positioning and discursive redescriptions in this study as Tan and Moghaddam (1995) point out “cannot be considered in isolation, removed from a consideration of the specific moral orders in which they were operating” (p. 393) A satisfying discussion of the positioning of each teacher required the inclusion of totalising social or cultural considerations, such as socio-economic class distinctions although these descriptors were never used explicitly. Cultural factors were often implied as shared horizons of significance, as structural reasons in explanation of teachers’ self or other positioning practices in physics education, but these reasons I found could not be taken as simple causes in relating their interpretations to their beliefs.

Wenger (1998) and Schatzki (2001) among others importantly distinguish practice and action in the focus of research. They argue practice precedes action which is situated in particular environments with particular people and within particular systems of meaning. Bullough (2005) argues that his longitudinal work on understanding individual teacher identities starts with their activities as the entry to making sense of what is intelligible to them in their socially constructed practice. The current study also serves to illustrate that a better knowledge and understanding of teacher development requires an increased focus on the agential space and habitus in which teacher identity has been constructed and reconstructed.

The conversational interviews provided extended opportunities for the teachers to discuss the dynamic process of their daily discursive practices, and the social influences on their choices and actions. When we understand these processes, we are more likely to be able to claim we understand the culture of physics teaching. In this study, some of the teachers have more freely shared their beliefs, their sacred stories, and were more reflexive in their positioning. These teachers valued physics teaching as self-expression, and the experiences and knowledge that arise from this, in a manner which showed how their commitment to their work combined a prospective vision for purposeful change which
integrated their students’ learning with their own agency. Their autobiographical narratives describe teaching and personal professional identity formation more as a “calling” rather than “just a job” (Bullough, 2008b). As Flores and Day (2006) suggest, when teachers are actively reflective about the process of making sense of what they value and experience, they display a clearer comprehension of their identity formation. However, generally there were in the teachers’ accounts of their ways of teaching, “and to [their] self, even in their mundane everydayness, which suggest something other than reflexivity” (Adams, 2003, p. 236) is influencing their positioning. The continuous occurrence of things in teachers’ daily practices such as what just happened to them in changing schools or being promoted in the moral order in different roles in their school or outside, is an “example of culturally located practices which curtail reflexivity, discourses of self as experienced ambiguously, more immersed in relations with others and shared experiences as meditative or passive” (Adams, 2003, p. 236). Hence in agreement with Adams (2003), the possibility of “a more complex and representative understanding of teacher reflexivity” (p. 236) and professional and personal identity formation is suggested in the teachers’ accounts presented here.

Furthermore, I found with Mansour (2009), like Merleau-Ponty (1962), as cited by Shotter (2013) that teachers “are involved in [a complex] world with others, in an inextricable tangle [of doings and sayings]” (Merleau-Ponty, 1964 as cited by Shotter, 2013, p. 133). Approaching this study, using multiple theoretical frames, or alternative discourses, as described in chapter 3, enabled me to explore different comparisons and similarities in the teachers’ accounts of their complex agential space, while dealing with the limits of what could or could not be said, and understood by me from within the teachers’ practice.

Teachers’ sacred stories, and voices that normally remain silenced, can become more explicit when the “realities” and “truth” are discussed especially in relation to their everyday practices and routine within their own institutional settings and local moral order. This is what I have been trying to attend to, to encourage teachers’ voices and more sacred stories to be revealed. The commonalities of teachers’ cover stories, as well as distinguishing differences across the teachers, have provided more refined knowledge and clearer insights. These reveal how individual teachers’ and institutions’ practices appear to have shaped the teachers’ everyday discourse in schools. Although it is broadly
recognised in the literature that individual agency, and social habitus, are co-constructed in teachers’ practices, social phenomenological studies such as this one are able to offer a finer grained description of the ontological processes by which this co-construction occurs.

**7.2 Implications for Existing Practice in Teaching and Teacher Education**

Teacher educators must equip themselves to engage with the representational language standards of teaching and external accountabilities of teaching, but must also engage with the responsive language of teachers. These representational language of teachers are often portrayed as competing realist discourses. It seems essential for teacher educators to seek to understand and interpret the influence of changing warrants of current outcome-based or standards-based state educational management regimes. Tobin (2012) points out that, although there has been an exponential increase in science knowledge and that on our world and existential being have been transformed by this knowledge, the structure of the secondary curriculum has not much changed in a half a century. Science education and teaching continue to be portrayed in some normative discursive circles as having an essentially instrumental function, to do with reproducing the technical class in society, rather than as the essential humanity that some of the experienced teachers in this study portrayed. Many similar concerns have been expressed by researchers in science education about the need for curriculum reform (Lijnse, 1998; Sarangapani, 2006; Tyler, 1949). Tyler (1949) points to the need for policy makers to be clear about the targeted mandated curricular objectives. “These educational objectives [have] become the criteria by which materials are selected, content is outlined, instructional procedures are developed and tests and examinations are prepared” (Tyler, 1949, cited in Sarangapani, 2006, p. 127).

Sarangapani (2006) highlights changes needed in relation to the issues and problems of curriculum construction, with an emphasis in terms of the “objectives, designing learning experiences and assessment” (p. 125). For any school to achieve its educational purposes, “it is important for the educator to clarify for herself what the school as an institution needs to take responsibility for, as well as how [the] discourses of reference groups in society may need to be recast from the child's and the school institution's points of view in order to become relevant [in the] curriculum [discussions of teachers]” (Sarangapani, 2006, p. 125).
In this regard and in particular resonance with the views of the experienced teachers in this study, Bruner (1960) observed that “in assessing what might be done to improve the state of the curricular art, we are inevitably drawn into discussion of the nature of motives for learning and the objectives one might expect to attain in educating youth” (p. 69). An improved understanding of what is, and can be expected of teachers and the practical intelligibility they can bring to this discussion, is a challenge to teacher education and research that seeks to influence policy deliberations.

Teacher education can address the expressive order of science teaching that is prominent in the teachers’ stories in this study. That is the organisation of honour and status concerned with the presentation of the self as valuable and worthy of respect. The early career teachers often felt they were not well prepared for their work as curriculum designers which they imagined or assumed were duties discharged by simply ‘following the rules’ which had not been explicitly revealed to them. The case studies of teaching practice presented in this study attend to teaching as product and process, rather than one or the other. Teachers in training should be equipped to work to achieve both outcomes. Narrative case studies could be developed to this end for pre-service or in-service teacher education purposes from scenarios (Shulman, 1991) described in this study to explore what Tobin (2012) points to as the implications of individual and collective relationships in teaching, as well as the relationships between an individual’s reflexive positioning, their purposes and social necessities in particular objects.

Often we tend to assume, within one discourse, a set of consistent choices have to be made as a result of what Davies and Harré (1990) call “the social and grammatical construction of a person as a unitary knowable identity” (p. 59). There is a strong sense in the conversational interviews that as Wittgenstein (1981) and Shotter (2011a) indicate, what determines one teacher’s judgements and choices, concepts and reactions, is not what the teacher sees themselves doing in any instant, as a person, but in the combination of daily actions that they are involved, the background against which they see an action.

Like any teacher, the physics teacher with a power relation, in relation to explanations of their discipline and to their students, in the complex social world of their school must present multiple personae. These personae include those appropriate to other standard classroom roles, such as also being a mathematics and science teacher or management role as a curriculum coordinator, head of department or daily timetabler. In this sense it
should be no surprise that the teachers in this study struggled to produce a story of themselves as a unitary and consistent, logically and morally coherent person, independent of their particular context as a physics teacher. In their transactions in their school community, with their students or significant others they are expected to do so, of being logically and morally coherent person. The young teachers could be expected to be more insecure in this regard. The kind of person they are accepted as, in the “role” of the physics teacher, depends on their everyday performative doings and sayings related to the enactment of broad social norms.

The epistemological authority of a teacher’s belief, that they are good teachers, rests with the considered collective judgments, Roberts (1996) argues, of their colleagues in the physics or science department, who alone understand both the knowledge domain and the local context. As there are fewer senior physics teachers in most, if not all secondary schools, than any other subject area, there are likely to be fewer semiotic interactions in which the socially constructed beliefs of a teacher about student learning, teaching and its pedagogical resourcing in the physics domain, can be rehearsed. Certainly such professional interactions would be more intense in the various whole-school roles for which the experienced teachers have accepted responsibility. At a junior level this has been in technology support or mathematics department coordination.

It can be observed in the case studies presented in this study that the physics teacher’s personal professional identity formation is more likely to develop in the discursive circles of management or social organisation of the school, than in the physics domain, unless they maintain “expert” conversations with physics teachers in other discursive circles such as in the Institute of Physics Education Sub Group or in the Victorian Curriculum and Assessment Authority Board of Physics Committee. In this study, these “expert” teachers are also teaching in schools where there are a number of senior physics teachers are employed. The experienced teachers positioned themselves in storylines that much more frequently referenced institutional practices which they had initiated or instituted. They rarely positioned themselves in a broader societal rhetoric to do with education generally, or the purposes, policies or character of the existing physics curriculum. The illocutionary force of their storylines prioritised generally the importance and personal significance of the expressive social order, over maintenance, and the authority of their own experience and extended reflexivity within the norms of the discourse circles in their
schools, nested within the maintenance of the social status of the school. These normative
discursive circles were warranted with shared knowledge or at least not contradicted.
These storylines were presented as being learned both through textual and lived narratives
portrayed as objective, that is as the way it had to be for them personally, but not
immutably.

As discussed throughout, the storylines for each of the teachers in this study are complex
and always relate to their own school context which provide as a site-based ontology
(Schatzki, 2000, 2003). Schools are social sites which according to Schatzki (2005) are
comprised of “practices” and “orders”. Schatzki (2005) states that “practices are open-
ended spatial-temporal manifolds of actions [defined by] understandings of how to do
things, rules, and teleoaffective structures” (Schatzki, 2005) whereas orders which can be
taken as plans are lesson “arrangements of entities” (Schatzki, 2005, p. 473): students,
curricular concepts and pedagogical objects. The site ontology that a teacher shares with
others, is the way teaching is seen to be done at his or her own school. The teleological
structures of physics teaching include many constituents; “intentions, actions, emotions,
and moods as well as ends, purposes, projects and tasks” (Schatzki, 1996, p. 101).

Hargreaves (2003) reaches a similar view, embedded in ordinary language philosophy, to
Harré, that when teachers make their school as their moral commitment personally and
professionally, they construct their character, work ethics and other qualities for
themselves and others.

The self, portrayed through the teachers’ conversations, seems to be a “partial” totality of
oneself. In agreement to Benwell and Stokoe (2006) and Törrönen (2013), identities are
not be to assumed as complete individuals but as on-going construction of discursive that
keep changing in contexts and situations (Benwell & Stokoe, 2006; Törrönen, 2013).

Adams (2006) explains that “agency and autonomy are embodied in [Bourdieu’s] the
concept of habitus, but they are qualified by the caveat of accumulated history, both
personal and collective, which imprint themselves as pre-reflexive action-orientations”
(p. 515). Giddens (1991) argued that the self, in the contemporary world, is for everyone
a reflexive project. Teachers in this study generally, not just beginning teachers, are aware
that they have resources and are to make their choices to what they consider are important
and significant in the context of their school and their culture as well as the domain of
physics. Sometimes the teachers are to sort out their main concerns in order to get on with
their life through the process of orienting themselves, in everyday practice to the rules rather than “following” them.

The research shows teachers’ use of language is not only concerned with representational, or propositional knowledge, describing the “what” of physics teaching; it is also dispositional or relational, describing the “how” or skilled knowledge. However, beside these forms of knowledge, there was also a knowledge from “within” which the teachers employed to describe their commitment; knowledge which they felt was shared with others but never an identical practical intelligence. Physics teaching as a “form of life”, was encountered differently for each, but sustained the possibility of social action, which Schtazki (2010a, p. 152) indicates “specify ends and purposes, stipulate forms of activity and inform how objects and events can be used” in search of shifting formulations or of clarifying the expressive order of honour and status in a particular time space. Many features of the “mental life” of physics teaching are derived from local social forms, including the disciplinary discourse and the conversational realities of staffroom and classroom. Harré (2002) argues that,

“There is nothing else to social life but symbolic exchanges and the joint construction and management of meaning, including the meaning of bits of stuff. To become relevant to human life material beings [human and other entities] must be interpreted for them to play a part in a human narrative. Interpretations require grammars that are historically and culturally local” (Harré, 2002, p. 32).

Harré (2002) further indicates that for interpretations, history and culture of grammars are required. This has been revealed by Vygotsky (1986) how stable interpretations can be achieved when grammars are retained for centuries. A teacher’s discursive practices in this research, in agreement with Harré (2002) are social objects as their discussions framed dynamically in their storylines, about their classes and about others in their workplace. I agree with Shotter (2013), we have to put aside “the dream of obtaining very general, basic results in our [educational] inquiries. This does not mean that the limited, partial, and situated [phenomenological insights] we can obtain, will be of no use to us. They are just what we need if we are to move on from simply being ‘caught up in things’” (p. 152) in the practice of teaching from within the culture of physics teaching or teacher education.
7.3 The Culture of Physics Teaching: A Cross-cultural View

This study has grown from my commitments as a physics teacher and educator, as well as an early career researcher in Brunei. Although there are major cultural differences between Australia and Brunei, both experience an established way of thinking and discussion on “reflexive positioning [and] is integrally associated with local normative systems through cultural ideals, which act as guides for [teachers in each] culture as they position themselves” (Tan & Moghaddam, 1995, p. 393). These traditions, the Western broadly speaking, and that of Islam, appear to hold common features that highlight “intuition as a guide to universal truth. Both seek a ‘freeing’ of the self, in order to allow the self to have what they regard as a ‘higher’ form of experience. [Both are] concern[ed] with the ideal self. This ideal is then used to position self and others” (Tan & Moghaddam, 1995, p. 394). In reflexive positioning, in the Western tradition, wanting to become a better self, a better physics teacher, and self-improvement is understood to be a logical individual project which is often felt to be impeded, but sometimes facilitated, in society. It is understood as not achieved through pure reason. As Dostoyevsky (1996) observed a world is dialogically constructed, “You see, gentlemen, reason is an excellent thing, but reason is nothing but reason, and satisfies only the rational side of man’s nature, while will is a manifestation of the whole of life”.

The “essential self” as explained by Tan and Moghaddam (1995) can be taken as the position from which we take the teachers as authors of their words and actions, doings and sayings. “I should be doing better by my students and school”, that give a place to guilt as awareness of negation and acknowledges both an internal structure of concerns and a cultural normative framework. This which directs the focus for discussion away from the notion of the authentic individual as somehow operating in isolation from the real world and places it instead on the quality of his or her relationship to the world. This process of self-improvement, Tan and Moghaddam point out to be seen in the West to start at “the point of departure outside the body [and social world]” (p. 395). In Islamic traditions, self-improvement occurs from inside the body as stated in the Quran “God does not change a people’s lot unless they themselves change their own characteristics” (The Quran, chapter 13, verse 11).
Physics is classed as a “difficult” subject in schools in Brunei and in many other parts of the world. The difficulties even the “expert” teachers in this study often had in discussing the teaching of physics, especially in terms of its nature could not be attributable to weaknesses in their pedagogical content knowledge of the abstract symbolic logic through which physics has so successfully elucidated material causes. Perhaps, the reason that physics is classed as a “difficult” subject, relates to the discussion about it, especially in terms of its nature, that the teachers found was not be easily discussed. However, there is an understanding among these teachers that the difficulty may not reside in the prior learning of a large number of concepts, but with the struggle within the student to want to learn physics. Wanting to learn academic physics is a manifestation of the whole life of their students that each teacher knows they must educate. This is clearly more difficult for some teachers in some schools than others.

In reference to Moghaddam (1999, p. 80), the teachers’ reflexive positioning practices diversify according to:

- “the particular cultural ideals [the teachers] desire to move toward through positioning;
- the particular dimensions which [they] found relevant in positioning themselves and others [including importantly their students in their discursive and non-discursive practices]; and
- the preferred forms of autobiographical telling: [cover, sacred and secret stories seemed to] influence the types of stories [they shared] about themselves in the process of positioning” (1999, p. 80).

Tan and Moghaddam (1995, p. 388) suggest research in teacher identity formation as pursued in this study opens two new possibilities. They are

- “to extend the positioning concept to the intrapersonal level in an exploratory fashion, and
- “to broaden the scope of the positioning discussion by considering how positioning practices are culturally imbedded” (1999, p. 80).
What seems clearer to me is that the culture of many schools provides such as in this study limits of reflexivity, but as already noted by Adams (2003), “there is more to contemporary culture” (p. 237) in Melbourne, Australia or Brunei “than the hegemonic discourses championing rationality, self as project, consumer and atomized individual and an acknowledgement of alternative discourses [in physics teaching] in contemporary culture” (Adams, 2003, p.237). Furthermore, Adams (2003) points out that these “alternative discourses can provide us with some alternative understandings of reflexivity which are less fashioned on rationality and reason, and may even acknowledge their cultural situatedness” (p. 237). As all the teachers in this study show in their autobiographical accounts, their reflexivity is as explained earlier, “never a complete process, surveying all before it. It is always based on certain cultural frameworks” (Adams, 2003, p. 237), influenced by discursive circles in their micro-culture, which allow the teachers to interrogate the local moral order in some ways, but to accept others without such interrogation.

The experienced teachers, except for Kate, in this study identified the broad importance of professional dialogue including in schools the mentoring beginning physics teachers. An understanding of physics teaching, like life, Adams (2003) argues is “too profound and unknowable to be contained in a reflexive understanding” (p. 237). Adams further argues that “ambiguity and mystery, which seems [often] to be overlooked [in much of the science education research reviewed], or at least inappropriately apprehended in [belief in an extended, or] ceaselessly appropriating reflexivity” (Adams, 2003, p. 237). The teachers were not just referencing induction into the teaching world, but also its complex realities, which were felt to both acknowledge and mystify the “basic” epistemological status of physics in science and the whole curriculum. I take this to be a strong recognition of the essential myth and mystery of physics teaching for them as a form of life. This in turn points to the need for researchers, as well as teacher educators, to attend to ontological processes and not just social representations of the practical intelligibility of teaching. Kate, spoke of learning to teach physics the hard way, by herself, in a difficult school.
7.4 Reflexive Self and Culture

The significance of this research lies in its potential contribution to the provision of better descriptions of how teachers’ identities are dynamically formed, in site-based social ontological processes influenced by cultural horizons of significance. This study aimed to understand how a small group of physics teachers each perceived the practical intelligibility of physics teaching and their identity formation in this field of practice. Following suggestions by Törrönen (2013), the qualitative data sets required analyses in “classifications, participant roles, structures of viewpoints and [interactive] positions [that needs analysis from different perspectives in order to understand] local, cultural and societal subject positions [and identities as physics teachers]” (Törrönen, 2013 p. 94).

I position myself as research/teacher educator in a post-modern context as according to Törrönen (2013), “essentialist identity theories have met increasing criticism since the linguistic and discursive turn in the social sciences” (p. 80). This research context is recently explored in studies of science teaching and particular physics teaching, in which epistemology has often been thought to be enough. In agreement with Adams (2003), I saw that in teaching generally, it is important to seek “a more complex and representative understanding of reflexivity and self identity” (Adams, 2003, p. 236). This is because reflexivity and self identity influenced a sense of authentic learning of the subjects and their students and the teacher-student relationship in schools seen through the lens of the social horizons of disciplinary cultures. The expropriation of dialogue in the teacher case studies across cultures on common concerns can serve as the context for incubating new cultural forms in teaching and teacher education.

I see the necessity to understand teachers’ calculative and meditative thinking about their authenticity around authoritative principles, rules, values and norms of practice, and what and how to change these practices to be more effective but in different senses. The human-thing relationship between self and physics teaching can be distorted by ignoring the Aristotelian poesis of the practices of teachers and their practising ideas which need to be incorporated to reinstate a broader and more human world-as-it-is dimension in science education research and teacher education across and within the horizons of significance that our culture provides.
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Appendices

Appendix 1: Education System in Brunei

For nearly 100 years, before Brunei gained its independence in 1984, Brunei was under a British Protectorate. Hence, our education systems were influenced by the British education system in particular with our secondary education examination system adopting the British Cambridge General Certification of Education (Cambridge International Examinations, 2013). After 1st January 1984, His Majesty, the Sultan became the supreme ruler and proclaimed Malay Islamic Monarchy (MIB) as the national philosophy of Brunei. MIB blends Malay language and customs with the teaching of Islam in everyday life and activities within the monarchial system. The teaching of Islam through the national philosophy of MIB helps to incorporate the Brunei education system.

The general philosophy of science education in Brunei as stated by the Curriculum Development Department (CDD) is that:

“Science stimulates and excites pupil’s curiosity about nature and the environment around them. This curiosity can be satisfied using scientific enquiry, through which pupils acquire scientific knowledge and skills, and learn how to develop and evaluate explanations based on experimental evidence and modeling. This is a spur to critical and creative thinking. Through Science, pupils also understand how major scientific ideas contribute to technological change; the impact that science has on industry, business, medicine, environment, and improving the quality of life. By scientifically literate, pupils learn to question and discuss science-based issues that may affect their own lives, the direction of society and the future of the world” (CDD, 2002, p. 3)

The Ministry of Education is responsible for providing and developing a vision of quality education. The Brunei education system has developed and implemented a 21st Century Education system. The system aims to instill both strong moral values and foundation for students in Brunei. Educational planners and policy makers in Brunei see the key subjects of Science, Mathematics, Languages and ICT as contributing to the growth of the scientific and technical literacy within the workforce, thereby enhancing the growth of the country economically and industrially.
Appendix 2: Personal Meaning Mapping (PMM) by one of the experienced teachers
Appendix 3: Personal Meaning Mapping (PMM) by one of the early career teachers
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Title:
Explorations of the moral socio-cultural contexts of the intentional action of physics teachers: case studies to inform practice and teacher education

Date:
2017

Persistent Link:
http://hdl.handle.net/11343/210791

File Description:
Explorations of the moral socio-cultural contexts of the intentional action of physics teachers: case studies to inform practice and teacher education

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