An Investigation into Secondary Science Teachers' Use of Research to Inform Their Science Teaching

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ABSTRACT

The perceived irrelevance and lack of accessibility of academic research for science teachers has long been recognised as a significant problem in much educational literature. While interventions have been suggested to enhance applicability and accessibility to support teachers in their use of research findings, too little attention has been paid to how teachers' access findings and how use of findings influences teachers' learning. There is a need for investigating efficiency of access to research findings and use thereof for enriching science teachers' subject content knowledge and pedagogy.

This study explored ways in which science teachers access findings, how they reported these influence teacher pedagogy and practice and the factors that affect motivation of teachers to access research findings and develop as reflective practitioners. Exploration into teacher learning as a result of engaging with research findings that specifically results in the teacher changing teaching pedagogy is also undertaken.

Guided by an interpretative inquiry, this study initially administered a questionnaire to a group of thirty five secondary science teachers and answers analysed to guide and inform further questioning. Subsequently, semi-structured interviews with nine science teachers provided data that was also analysed to explore teachers' use of research findings.

This study argues that a focus on making research findings accessible to science teachers is in the interest of teacher learning and should be considered priority for researchers, those publishing in educational research and for those planning professional development programmes for teacher learning. In addition, both failing and successful strategies for disseminating findings and the ways access and use of findings by teachers can be enhanced. This study also gives science teachers some insight into making use of research findings to inform their own teacher learning, pedagogy and practice by a deep engaging with research findings.

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Introduction

Chapter one provides the rationale investigating science teachers' access and use of research findings in their teaching practice. It firstly provides an introduction to the research study, followed by a reflection upon my personal experiences that shaped the development of the study. A background to the study is then presented and supported by a justification in the broader New Zealand context of science teaching. In addition, the specific research questions that guided the study are introduced, and the significance of the study is discussed before finally providing an outline of the chapters in this thesis.

1.1. Introduction

There is a wealth of information available in education and science education research that can shape and possibly influence teachers' practices. The focus of this study is an interpretative one to gain insight into the published material and research findings accessed by science teachers and how teachers' perceive that this engagement has shaped aspects of their teacher learning and teaching pedagogy. This focus stems from the notion that one of the purposes of the work of educational researchers is to inform policy makers and researchers and to make relevant research accessible to teachers in order to increase their effectiveness in the classroom. However it is not clear what published material science teachers are actually accessing.

In 2007, Barber and Mourshed (2007) released a report on those educational systems in the world judged to be most successful at promoting student learning and identified the most important distinguishing characteristic as that of consistently effective teachers. At the heart of this study is an interest in ways of developing science teachers' pedagogy to

increase their effectiveness, and through this impact positively on science learning for students.

In embarking on this research, I hoped that the findings from such a study could inform and be relevant for researchers, those publishing educational research and for those planning professional development programmes for teacher learning. It is also intended to motivate science teachers to consider using research findings to inform their own teacher learning, pedagogy and practice to become even more effective science teachers.

The topic of this thesis was first considered when I was reading a chapter in John Loughran's (1999) edited book *Researching teaching: methodologies and Practices for Understanding Pedagogy*. Of particular resonance to this thesis was Mitchell's (1999) statement in a chapter of the same book that "there is a gulf between educational research and teaching practice…the great majority of published research has little or no influence on teaching practice" (p. 44). Admittedly, as Millar (2003) pointed out, not all science education research is purposed for use in the classroom, but may be orientated to influence policy and/or curriculum. However, Mitchell argued that for many teachers, research has little or no influence on their teaching. He considered that the perceived irrelevance and/or lack of accessibility of academic research, especially in terms of the manner in which ideas are communicated, results in teachers who do not enrich their subject content and pedagogy from research findings. This study is aiming to determine if this is largely applicable to a group of science teachers in New Zealand.

Literature indicates that in the cases where research is purposed to assist or change classroom practises, there may still be a problem. Ideas represented by academic research may be abstract and there exists a disconnect between the research and the place where ideally the research should eventually be applied: the classroom. Mitchell (1999) attributed this to research literature as often missing the necessary "craft knowledge" (p. 45) of teaching. Here he is referring to the "classroom wisdom that is so

essential for any intervention or change to be successful" (p. 45). This *'classroom wisdom'* includes, for example, the best time and method to introduce concepts, what students' first attempts or reactions may be, any common misunderstandings for the teacher to look out for, and how the teacher may eventually extend the learner (Mitchell, 1999).

Loughran (2007) emphasised that:

> *… much of the teacher as learner literature tends to focus on the development of understanding and knowledge of teaching generally, rather than being content specific" (p. 1044).*

Mitchell (1999) concurred with these ideas as he succinctly explained that teachers want "ideas and advice that resonate with their own experiences and their own problems and concerns" (p.46). Teachers need to position new information and recommendations within their individual teaching practice and interpret ideas for their own context. In order for research to be useful to the teacher, it should include short-term contextual detail. Mitchell goes on to say that teaching is a highly complex activity and contexts must be transparent. This suggests that teachers need to engage with research findings on a deep level and may struggle transferring too generalised ideas into different contexts. Significant ideas may be implemented once a teacher has reflected on their own teaching practice and pedagogy in light of using research findings.

This suggests that a significant set of skills is required for teachers to engage, interpret and apply research findings to their own context in their own individual teaching practice. This study hopes to reveal how teachers access and apply research findings and the factors that affect this.

1.2. Focus and background

The background that shaped my interest in this research is based on reflecting on my own science teaching and how I perceived, in the early careers years at least, that research findings had had little impact. It was only during study and research work for an honours degree in 2000 that I began to use research findings as a teacher learning tool for reflection of my own teaching practice and pedagogy.

A significant part of my own schooling experiences guided my reasons for wanting to become a science teacher in the first instance. I grew up in a rural setting, attending the only English medium secondary school in the area. Due to a national shortage of science teachers at the time, our science lessons were timetabled but were substituted by non science teachers and the learners were expected to 'learn' by reading the textbook. Despite still achieving remarkable results, I was always disappointed that I was unable to engage in practical work or have a 'source' to have scientific questions answered. Determined, I continued with my own physics and chemistry education through a correspondence school, yet on reflection, it was not the ideal way to learn science. As a school learner I had never observed any form of science teaching, whether it could be regarded as poor or excellent. It was with this lack of experience that I entered university and became enthralled by both physics and chemistry theory and practical laboratory sessions, engaging the lecturers in question and discussions at every opportunity. It was a combination of these experiences that has driven me to constantly reflect and learn in the science teaching profession.

After completing my undergraduate studies, I taught secondary school physics and chemistry for a few years. Subsequently I commenced and completed an honours degree in Education, focussing on a research study of alternative chemistry conceptions of pre-service science teachers (Van Der Merwe, 2000) whilst at the same time lecturing physics and leading

professional development for a large group of secondary science teachers. It was during this time that I became intrigued with the professional development of secondary science teachers. Thus, even though I returned to the classroom in the subsequent years, I continued to be involved in leading professional development for colleagues in our area as a cluster leader. Most of the development focus was on outcomes based education assessment. I found that my own professional learning was enhanced through interaction with research findings and through engaging with colleagues whilst there was a collective focus on reviewing and reflecting on research findings. I continued to teach both physics and chemistry for a number of years throughout the senior secondary school up to year 12 learners. I later taught previously disadvantaged children, preparing them for their school-leavers examinations in physics and chemistry.

After immigrating to the United Kingdom I taught physics and chemistry as a semi-permanent supply teacher for lengths of a term at a time. Of prominent influence on me during that time was the variety of colleagues that I encountered in an assortment of secondary schools. Some professional science teachers engaged at length with research findings and applied these to their classrooms, yet other teachers did not seem the least bit interested in research findings. In one school, a large grammar school in Berkshire, where I relief-taught for two terms, Mr Brown (pseudonym), a physics head of department made a marked impression on my professional learning. Despite his entrance into teaching being a relatively late one, after working for years as an engineer, he inspired me with his vast knowledge of both physics subject matter and teaching pedagogy. In our open office, in discussions with me and our colleagues, he would regularly refer to journal articles and he seemed to inspire the professional learning of the physics teachers in his department. For me, Mr Brown's enthusiasm for learning from published research was almost infectious and something to aspire towards. I often reflected on his positive

approaches to engaging with research findings and to professional learning.

Since immigrating to New Zealand in 2010, I have commenced my Master's thesis. The reasons for commencing this study were twofold, namely desiring to learn more about the professional development of science teachers, and secondly, as I would like to return to the science classroom subsequent to completion of the study, I could do so with current knowledge relevant to the New Zealand science education context and having developed my ideas on the basis of careful research dissection.

Often teachers are seen to only develop through structured professional development sessions, but I specifically want to know three things: how teachers access and apply research findings in their teaching practice; what types of research science teachers were accessing and how significant research has been in their personal responses to transforming practice; and thirdly, I was intrigued to determine what motivated teachers to access research findings and how this impacted their teaching.

1.3. Thesis justification

Just recently, in Sir Peter Gluckman's (2011) report to the New Zealand Prime Minister identified that that "the biggest problem a science teacher has is that no matter how well qualified they are when they leave university, given the pace of change in science …their capacity to maintain knowledge of relevance to what they need to teach is limited by time" (p. 6). Changes in both educational research and science educational research as they are relevant to teaching requires that teacher are constantly engaging with research findings to develop their pedagogy and to make science relevant for learners.

This study asserts that the reading, assimilating and responding to educational research and science education research findings can and should have an impact for the teacher on her or his:

- science content knowledge;
- pedagogical content knowledge and
- the nature teaching pedagogy in interaction with the students.

Thus the primary purpose of this study is to investigate how research findings inform pedagogy and related pedagogical issues for secondary science teachers in New Zealand.

It is my belief that excellent secondary science teachers are vitally important in fostering effective, relevant and engaging science learning for students. To enable the provision of this type of science education, the teacher is required to reflect on their practice, change, transform and develop to be the most effective science teacher possible.

Reflective practice has become an important part of the teacher assessing the effectiveness of his/her own teaching. Loughran (2007) explained that the view of quality in teaching has become aligned with teachers learning about teaching by reflecting on their own practice. This learning ideally occurs through the pre-service science teacher as learner phase all the way through the beginning teacher and experienced teacher stages and on through to the retirement from the profession of teaching.

Kelleher (2003) equated good teachers with reflective practice in relation to their professional development.

> *Good teachers are by nature reflective learners. Teachers work together developing specific goals for student achievement; they work together through many professional development activities, such as action research or the examination of student work; and they collaborate in evaluating the results of professional development pursuits (p. 755).*

The reflective teacher should be able to identify important precursors to change and explain the way they have developed and changed their content knowledge and pedagogy in relation to the knowledge gained from research findings.

1.4. Research Questions and Design

Based on the background discussed in the previous section, three research questions have emerged to guide this study:

- In what ways are research findings accessed by science teachers?
- What do science teachers report influences the ways in which research findings inform pedagogy and practice?
- What are the factors that affect teachers' motivation to access research findings and develop as a reflective practitioner?

In order to answer these questions, the research design included a questionnaire to gain general information from participants, followed by semi-structured interviews to further probe science teachers' access to research findings and their use thereof to inform pedagogy and practice.

1.5. Significance of the study

Lifelong learning has become synonymous with professional teacher learning. We live in a time when there have been changes in every sphere of knowledge pertaining to science and learning it: educational, growth in scientific knowledge, scientific tools and technologies, and scientific theories with rapid developments of expertise within and among knowledge workers (Duscl, 2008). This has been accompanied by vast amounts of educational and science education research findings, the

impact of which on teaching practice is apparently so slight (Millar, Leach, & Osborne, 2000). The perceived irrelevance and lack of accessibility of academic research for science teachers has long been recognised as a significant problem in much educational literature (Hargreaves, 2000; Millar, 2003; Mitchell, 1999). In order to maintain relevant and current knowledge in these times, teachers need to interact with new knowledge, as part of the process of lifelong learning. This study investigated and quantified the teacher learning currently occurring and identified ways in which the effectiveness of research findings impacting on teachers may be enhanced.

This study is concerned with assessing how secondary science teachers currently engage with research findings and whether that enhances their teacher learning. In the context of science teachers, the access and use of research findings is determined and the effective means of access identified for the science teachers.

It is hoped that the findings of this study could contribute to the education research community, by highlighting effective formats in which research findings are disseminated and indicating the formats that are ineffective in causing teacher transformation. The findings may advise professional development practitioners of some areas of deficiency in the professional learning of science teachers. The findings may have implications for the manner in which teachers implement research findings.

1.6. Outline of Thesis Chapters

This thesis is organised in to five chapters. Following this introductory chapter, chapter two explores the relevant literature relating to the ways science teachers' access research findings and their use of research findings in influencing pedagogy and practice. Chapter three explains the theoretical perspectives that underpin this research; particularly the choice of the research methodology used in this research and introduces the

design of this study. It also gives an indication of how the data was analysed and discusses the relevant reliability and validity issues or their equivalent. Chapter four details the data collected in the research, including both quantitative and qualitative data. Chapter five, the final chapter, ties the data analysed with the literature reviewed in relation to the research questions. This also highlights the limitations of the research and draws conclusions and implications for the future of teacher learning and professional development projects.

Chapter Two

Literature review

2.1. Introduction

In this chapter, relevant literature is explored regarding science teachers' access to research findings and their use of research findings in influencing teachers' pedagogy and practice. The approach begins with a more generalised view of educational research and gradually looks at more specific and individual uses of educational research and its access by teachers in informing their pedagogical practice.

Chapter two is divided in to six sections. First, an holistic view of the historical nature of educational research and its orientation to teacher learning is presented. Secondly, the epistemological position of learning theory as related to teacher learning in general is discussed. In the third section, the relevant literature regarding teacher knowledge and in section four, some of the literature related to teachers' learning is examined. Fifthly, the professional development offered to possibly enhance teacher learning is explored. Finally, the role of reflective practice pertaining to teachers is reviewed in relation to its influence on pedagogical practice.

2.2. Educational research

Throughout this thesis the term 'educational research' will refer to both general educational research and science education research unless otherwise specified. The term 'research findings' is also inclusive of research findings given as a result of both educational research and science education research unless the contrary is made explicit.

The literature related to the educational research and its use by teachers exposes different views, given by researchers and teacher practitioners,

revealing the history and some criticisms. These are all discussed in light of how science teachers may access and use research findings in their teaching.

Researchers' perspectives

In Fensham's (2004) book entitled '*Defining an Identity: The Evolution of Science Education as a Research Field'* he discussed 'research to practice' in chapter eleven, explaining how at least half of the 79 individual science education researchers that he had interviewed associated significant research, in a broad sense, with the improvement of practice, as having consequences for teaching and learning. It was obvious to the author that some researchers, in referring to their significant publications, did ally themselves with the improvement of teaching practice, and hence by implication, with increased student learning. Significantly at least half of the researchers indicated that an important outcome for their research was to impact on teaching.

However previously Jenkins (2001), implored researchers to consider what science education research can realistically contribute to improve teaching practice. He considered science education valuable for reasons other than improving practice. Guskey (2003) in reviewing recommendation lists for effective professional development found, surprisingly, that less than one-third of the lists stressed that professional development should be based on the best available research evidence. This, he goes on to say "is particularly striking given the long-standing criticism of professional development that focuses on fads and bandwagon movements rather than on solid evidence of what works with students" (p. 748).

As we will see in subsequent discussions, considering that professional development is regarded as the primary vehicle for teacher change and thus for teacher learning, the evidence that professional development and hence teacher learning is not always based on research evidence is a concern.

Types of educational research

McIntyre (1998) proposed that there are five types of educational research, with each having a different relationship to policy and teaching practice, these are:

- research anticipated to enlighten new policy or practice;
- research evaluating existing policies or practices to inform subsequent events;
- action research intended to improve education in a particular context and to produce an understanding of that and comparable contexts;
- research intended to identify practices that are particularly successful; and,
- research aimed at producing new knowledge, (the impact of which on practice is to be determined).

Gilbert, De Jong, Justi, Treagust and Van Driel (2003) expressed that all these types of educational research are relevant to the study of chemical education and also added a sixth type of research applicable in this field: “research undertaken from a particular psychological perspective that is carried out on chemical education as an exemplary domain” (p. 398). Furthermore, these researchers went on to discuss that there is too high a proportion of research anticipated to enlighten practice, (first type mentioned by McIntyre above) but that the required development and evaluation work does not follow this type of research as it should. Gilbert et al. also reflected on the types of research, and concluded that there is insufficient quantity and effectiveness of all the other types, especially in chemistry education.

Impact of educational research - Teachers’ perspectives

There is debate as to what extent educational research has impacted the necessary practice. Teachers largely do not depend on educational research conducted by academics to inform and improve their practice

(Zeichner, 1995). The perceived lack of influence of educational research on teaching practice has been a concern for many decades, as Kennedy (1997) explained in her historical account. This lack of teachers' interest in research and their inability to interpret and implement findings has also been a concern of researchers for some time (Jenkins, 2001; Russell and Munby, 1991; White, 1999; Brew, 2006). The researchers indicated that the problems associated with the lack of teacher interest related to the methods used to disseminate findings to teachers and the lack of application of concepts to the classroom. Furthermore, Kempa (2002) considered that even experienced science teachers continued to teach in 'ignorance' as they were unaware of research findings that had been produced by the science education research community.

Gilbert et al. (2003) in the book entitled '*Chemical Education: Towards Research-Based Practice'* explained that "all aspects of chemical education should be clearly associated with research" (p. 18), however they also emphasised that they realise that this did not occur in practice, asserting that

> *The consensus amongst teachers of chemistry seems to be, in our experience, that research currently has far less impact on the development of theory, policy, or classroom practice, than the researchers in chemical education would wish* (p. 400).

Although the comment made by Gilbert and his colleagues was relevant to a European setting, other research done elsewhere seems to mirror this. Research done in Portugal (Kempa, 2002) showed that teachers largely drew on sources other than research literature for professional knowledge. The sources included 'personal experience', 'common sense', official documentation and 'a consensus amongst professionals'. The view is that similar findings would be evident in other countries or in science education research (Gilbert et al., 2003).

As Millar (2003) discussed in his presidential address, it was Hargreaves (2000) that had previously argued that teaching was not a research-based

profession, that huge amounts of educational research were not regarded as scientifically sound to contribute to professional action in teaching and considered some of the educational research as second-rate. Gilbert et al. (2003) however contended that both policy-makers and practitioners alike are inadequately informed by educational research and attributed this lack of impact due to major stakeholders and the way research is funded and organised.

Both McIntyre (1998) and Gilbert et al.(2003) summarised six reasons as to why research has not impacted practice. They agreed that much of the research undertaken and reported in this area: has been funded on the basis of an excessive reliance on peer review thus this may not be of interest to classroom practitioners; has been undertaken with too low a level of involvement by major 'stakeholders', i.e. enquiries did not actively involve either policy makers or classroom practitioners; is on too small a scale and hence fails to generate findings that are reliable and generalisable across contexts; is presented in mediums (academic research journals) and in a language register which is largely inaccessible to a non-academic audience; lacks interpretation and significance for a policy-making or teacher audience and finally that research may be ignored by teachers because it may challenge their personal beliefs about science teaching.

Furthermore, McIntyre (1998) gives an alternative view to David Hargreaves' (2000) claims about the lack of impact of educational research, expressing that this view is "unjustified and ill-judged" (p. 189). McIntyre (1998) argued that the fault is poorly planned and inaccurate transmission of professional development for teachers and it has been suggested that a greater impact of research findings on teachers' practice could be made if teachers were "given more opportunity to take advantage of what research can offer" (p. 189). These opportunities may well be in the way of provided formal professional development, but also through easier access to research findings, as will be discussed further in subsequent sections. A caution given by McNamara (2002) however is

that shortened versions of research findings may include a “failure to define terms, ... or supply contextual information, or disclose methodology” (p. 24), thus findings may not be viewed in context or the implications for practice may not be obvious.

Historical influence

Loughran (1999) maintained that “an important way of conceptualizing research is by considering it to be seeking answers to questions and, …. that the questions are those which are important in the teaching and learning environment” (p. 3). Until two decades ago, it was mostly positivistic researchers that influenced changes to professional decision making (Guba & Lincoln, 1994; Duscl, 2008). For example, in the early 1980’s, Shulman (1986) recognised the contribution that the qualitative paradigms were beginning to make to understand teacher knowledge development. Evidence-based research dominated as the only type that “counted” to influence change, however, a significant amount of qualitative paradigm influence has subsequently been seen.

Many researchers have reflected on the history and changes that have taken place in educational research, particularly in the last fifty years (Duscl, 2008; Millar et al., 2000; White, 1999). There have been vast amounts of science education research in particular, in the last three decades (Millar et al., 2000). White (1999) considered the impact that educational research in general has had, and continues to have on the quality of teaching and learning, namely that: detailed observations and measurements have replaced superficial ones; teachers have become partners and principals in research and thus individual motives and actions have been studied in more depth; instead of a mere diagnosis of problems, more recent research points towards a search for reasons and particularly how education practices can be improved, thus making education applicable to the context considered.

It may be regarded that research findings could and should have a greater impact on teaching practice as more research is done and answers sought to identified problems, yet as the same editors identified, there was still concern that the impact of research on teaching practice had been minor.

The complexities of educational research

Educational research, as a social science research, is burdened with the complexities of humans and social interaction. Usher (1996) argued that the nature of educational research is useful when seen as open and indeterminate in relation to social events, processes and phenomena. In addition, educational research is influenced by history, culture, politics and ideologies, and there are real pressures on researchers to remedy problems in the educational field. Thrupp (2010) warned that too frequently educational research is not neutral or objective (as some may regard it), but it is an "inherently political act" (p. 119). Curriculum policy is, in most instances, the consequence of political compromise. The teaching of science and the views of teachers will be influenced by the curriculum. Teachers' personal theories and perceptions of learning, and pedagogy will no doubt also be influenced by political orientated policy. Within the framework of this study, the researcher will endeavour to keep this complexity in mind.

Another complexity for teachers may be the varying degrees of opinions and outcomes reflected particularly in science education research. For example Haigh, France and Forret (2005) explained that in order for children to be scientifically literate, they need to be actively involved in exploring and experimenting in the way that scientists do. Yet, another notion says science at school should focus more on the study of content relevant to children's lives and building rich experiences of the world around them in personally meaningful contexts, rather than on turning them into little scientists (Jones & Baker, 2005). This is an illustration of how research may be interpreted and thus implemented differently in science classrooms.

Educational research in teacher education

Many early career teachers may have received a large amount of research findings in their teacher education diploma, however Russell and Munby (1991) cautioned that it may be an error to assume that the research findings make an impact on the practice of early career teachers.

> *Teacher education seems to rely on the premise that propositional knowledge from lectures and books can be translated directly into practice. This premise fails because it cannot explain how the act of teaching is used by the beginning teacher to acquire practical knowledge….we have seen novice teachers, as they begin to teach, explicitly reject what they have been told in the Faculty of Education…* (p. 185).

In an attempt to bridge the gap between early career teachers and their difficulty in applying teacher education course knowledge to teaching, specifically in the area of pedagogical content knowledge (PCK), Hume and Berry (2011) worked on content representations. These were to assist student teachers, that subsequently become early career teachers, to make sense of research findings and to begin to "build knowledge of the components that they could then transform into a form of tentative PCK for particular topics and students" (p.354), despite them having limited teaching experience. The approach was predicted to have an impact on the professional learning of early career teachers, possibly enhanced through their collegiality with more experienced teachers. Further work by the writers will ascertain the impact of this approach for early career teachers.

In this section, a holistic view of educational research in its orientation to teacher learning was considered. In the subsequent sections this is related to learning theory, teacher knowledge and learning as presented in some of the literature.

2.3. Learning theory

How teachers use research findings to inform their teaching begins with learning and changes in understanding. The epistemological position of constructivism may be useful for understanding the perceived changes in teachers' pedagogy and subject matter knowledge. Moscovici and Varella (2008) explained that although the constructivist learning model was first named by Yager (1991), social constructivism was defined by Tobin, Tippins and Gallard (1994) as learning as a social sense-making process of experiences based on existing knowledge, additional experiences, and applications of the knowledge to new or unique situations. Although it is in the context of student learning, Labudde (2008) stated that "… the first and probably main principle of the constructivist view says: learning is an active process of constructing new knowledge based on existing knowledge" (p. 144).

Constructivism has been interpreted in many ways, yet most approaches value former knowledge, individual construction and social interaction in the learning process. Therefore, although constructivism is a learning perspective and not a teaching perspective, it is still important to consider the implications of constructivism in view of the learning activities of teachers. Teacher learning is influenced by context and prior experiences, which, according to Begg (1994), means that because teachers have a vast background of prior experiences to draw upon, and thus making sense of new experiences may mean reluctance to change their ideas. Furthermore, Begg (1994) argued that teacher learning is the responsibility of the teacher and not the provider or facilitator of professional development sessions.

Constructivism has played a role in teacher learning, as typified in the notion of reflection, which has become popular for teachers over the last few decades (Hoban, 2002). Reflection will be discussed in more detail in section five of this Chapter. In this study the way that research findings

impact on teachers' practice will be dependent on existing teacher knowledge and how new knowledge can be constructed.

2.4. Teacher knowledge

Shulman (1986) suggested a model for domains of teacher knowledge, initially identifying three types of content understanding, one of which included pedagogical content knowledge (PCK). Later work by Shulman listed PCK as one of the seven knowledge bases for teaching (thus removing it from a subcategory) and placing PCK "on equal footing with content knowledge, general pedagogical knowledge, curricular knowledge, knowledge of learners, knowledge of educational contexts, and knowledge of the philosophical and historical aims of education" (Gess-Newsome & Lederman, 1999, p. 4). Shulman (1987) subsequently stated that pedagogical content knowledge allows the teacher "to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by students" (p. 15).

For Shulman (1986) pedagogical content knowledge includes

> *… for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogues, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that makes it comprehensible to others…*
>
> *Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons. If those preconceptions are misconceptions, which they so often are, teachers need knowledge of the strategies most likely to be fruitful in organizing the*

> *understanding of learners, because those learners are unlikely to appear before them as blank slates (p. 9-10)*

Grossman (1990) later defined four cornerstones of professional knowledge for teaching as “general pedagogical knowledge, subject matter knowledge, pedagogical content knowledge, and knowledge of context” (p. 5). Of these four knowledge bases, Gess-Newsome and Lederman (1999) anticipated that PCK had the greatest impact on teachers’ classroom actions.

The focus of this study will be on how research findings have contributed or changed the teachers’ subject matter knowledge and their pedagogical content knowledge. Following is a further discussion of how teacher knowledge is changed in light of the above.

2.5. Teacher Learning

The research literature seems to use three terms interchangeably: professional learning, teacher learning and teacher professional learning. In this study I have chosen to use the term ‘teacher learning’ to denote teachers as learners, not to lessen the professional nature of teachers, but to portray teachers’ learning influences as wide-ranging. Consequently, teacher learning is used as a more inclusive term in this study, that includes teacher learning that occurs not only in professional development courses or workshops, but also teacher learning that takes place in many other context and aspects of teachers’ practice, including in school communities, in professional communities and in teachers’ own and others’ classrooms. Borko (2004) explained that in order to “understand teacher learning, we must study it within … multiple contexts, taking into account both the individual teacher-learners and the social systems in which they are participants” (p. 4).

Changes in teacher knowledge is teacher learning

Teacher learning is essential for educational reform as teacher learning is to be found in teachers' practices, is social in nature and is distributed across communities and tools, thus the inextricability of teacher learning is linked to the learning of others (students, colleagues and organisational learning) (Wallace & Loughran, 2003). Teachers' *experiences* and *biography* are the foundations that contribute to their knowledge about patterns of practice, content and resolutions to common classroom troubles (Wallace & Loughran, 2003). The writers go on to say that as teachers encounter new difficulties in teaching, they seek an outcome that is often based on knowledge they already had, thus teaching "becomes a search for a more settled rather than more effective practice — personal comfort, routine practice and classroom order being the teacher's primary interest at hand" (p.8).

Furthermore, literature on teacher change shows that teachers may actually overestimate the depth to which their teaching has changed due to implementation of teacher learning (Hammerness, Darling-Hammond, and Bransford, 2005). This may be a significant statement in light of this study that explores how teachers perceive changes that have occurred in their teaching as a result of reading educational research findings.

Teaching knowledge changes and proceeds gradually over time, as a teacher increases his or her range of experiences and understandings and thus learning, but change does not often occur through rapid surges of comprehension (Louden, 1991). Changes in teachers' knowledge may not occur from one-off workshop and change cannot therefore be assumed to be instantaneous (Hoban, 2003). This also resonates with Timperley, Wilson, Barrar and Fung (2007), a study that analysed ninety seven core studies, and found that generally effective learning opportunities had been provided over an extended period of time and involved regular contact with a provider. The authors emphasised that teacher change occurred over extended time, but what was more important was how the time was used. Changing teacher knowledge is a process that involves experimentation

with strategies and ideas, enhancing and upgrading of older strategies and ideas as well as solving problems (Wallace & Loughran, 2003). Although the literature indicates that substantial change in teacher practice is difficult, as it involves time, deep pedagogical content knowledge to be addressed and numerous occasions necessary for learning, it is notwithstanding an essential ingredient for lifelong learning.

An important factor for change was found to be teachers engaging in the learning process where change was heightened when a teacher was active in assessing their own learning and was granted responsibility to structure their own environment for learning in a school (Timperley et al., 2007). The researchers summarised that effective communities provide

> *… teachers with opportunities to process new understandings and challenge problematic beliefs, with a focus on analysing the impact of teaching on student learning* (p. xxix)

However, changes in teacher knowledge will not readily occur unless teachers are convinced that change is needed and unless teachers are given both the incentives and the opportunities for teacher learning to occur (Gilbert et al., 2003). Moreover, changes in teacher learning occur primarily when teachers require solutions to classroom problems, rather than when external imperatives for change exist (Wallace & Loughran, 2003).

The nature of teacher learning

In the last two decades, teacher learning has come to be informed by the theoretical situated perspective (Wallace & Loughran, 2003), or what has come to be called the ‘situative perspective’ by Greeno (1997, p. 15). This situative perspective differs from predecessor perspectives such as the traditional cognitive perspective in ways that give a useful framework to not only better comprehend the nature of teacher cognition and learning that has already occurred, but also how teacher learning can be fostered and encouraged in a social setting. The focus is not just on the individual,

but on learning through interaction with other people, with materials and systems (Greeno, 1997; Putnam & Borko, 2000).

Putnam and Borko (2000) indicated that the situative framework of learning has three central themes, namely that cognition and learning is firstly situated in particular physical and social contexts; secondly, is social in nature; and finally, is distributed across the individual, other persons, and tools. Wallace and Loughran (2003) avowed these three themes of situative perpective in their study of collegial groups that confirmed …

> *… the situated and social nature of teacher learning, but also indicates that learning is distributed across several individuals. Research into systemic reform shows that professional development has a much greater impact if it is locally managed and is focused as close to the classroom as possible – thus attending to the situated, social and distributed character of teacher learning* (Wallace & Loughran, 2003, pp. 9–10)

Situative theorists, Lave and Wegner (Wallace & Loughran, 2003) reinforced that the context of learning is considered to be as important as the activity itself, thus learning and the social and cognitive contexts are closely linked. Learning involves learning about not only knowledge, but also skills and situations all at once. Authentic learning activities for science teachers would normally be situated in and around the science laboratory, but the setting may vary dependant on the outcomes of the learning, for example around particular problems of practice.

Although Munby, Russell and Martin (2001) acknowledged that teacher knowledge is largely gained by experience in schools, they argued that there are many other elements that together may conspire against productive learning by teachers in schools. These may include “in-adequate facilities and resources, large classes of students requiring varied amounts of individual attention, insufficient time to prepare instruction and to respond in detail to student work, and, in some settings, responsibilities for controlling aggression and even violence” (p. 895).

Teacher collegiality

From the above discussion, teacher knowledge and change and therefore learning is, in part derived from social interactions. Thus professional collaboration groups are important because they facilitate professional learning and development needs (Wallace & Loughran, 2003).

From the discussion about the situative perpective, it is clear that the distributed nature of learning in the situative perspective puts less emphasis on the individual and focuses more on the teacher together with other members of the educational arena as well as interaction with a variety of documents and tools. The findings of Timperley et al. (2007) concurs with this as they also found that opportunities to engage in professional communities was important for teachers to be able to process new understandings as well as challenge problematic beliefs, in conjunction with close examination and emphasis on determining the effect of teaching on scholars' learning.

Teachers usually take part in a range of discourse communities (Resnick, 1991) that include state and district affiliation, formal and informal subject and professional groupings, school collegial groups and particular classrooms (Wallace & Loughran, 2003). Teachers are able to take part in these groups as they gain the tools, knowledge and language required to participate, thus learning occurs within the discourse community. The researchers also expressed how important it is to create rich occasions…

> *…for diverse groups of teachers to participate in, and to shape … teacher learning. Healthy and rigorous discussion helps develop new insights into teaching and learning, which are in turn shared across community members (p. 10)*

More recently communities have extended to include online technologies that may effectively to support both *continuity* in teacher learning and a sense of *community* amongst teachers, by sharing ideas about improving practice through an online community (Hoban, 2002). Loucks-Horsley, Stiles, Mundry, Love and Hewson (2010) gave many examples of the

types of online professional development available, as this means of support of teachers' learning has expanded exponentially in the last decade.

However, Wallace and Loughran (2003) cautioned that teacher collaboration groups cannot be made compulsory for teachers as successful groups endure by mutual trust and respect, and the members' common interests in students and teaching. When these components are absent or a teacher feels that they are better able to achieve lone-success, the motivation for group collaboration is reduced. Moreover, the researchers go on to discuss the dynamics that they found evident in successful professional groups. They state….

> *Group members look out for each other's personal interests and attend to the small matters of courtesy and caring that characterize good interpersonal relations. They understand one another, respect each other's strengths and weaknesses, and allow their partners space to move. Group leadership for this joint work sometimes involves a single individual who contributes unifying ideas but more often the lead role is shared or distributed around the group according to the interests and motivations of the members (pp. 8-9).*

The situative framework cannot imply that group learning would always necessarily be productive or that individual endeavours could not be a factor to assist teachers in being better social participants in their field (Greeno, 1997). The implications should centre on how learning activities contribute to teachers' development of increased "efficacy in their participation in valued social practices and to the development of their identities as capable and responsible learners" (Greeno, 1997, p. 9).

It can be concluded then that due to the distributed characteristic of the situative perspective, teacher learning may occur through informal school learning communities but also through the more formal communities as discussed above.

Nurturing and encouraging teacher learning

Hoban (2003) noted that research has time and again established that teachers cannot be forced to change, however if conditions are available to support their learning consequently some teachers will change their practice. The writer continued to say that in this way, teachers "genuinely offer individual leadership in science teaching and learning" (p.32). It has been suggested that if teachers are given more opportunities to take advantage of what research can offer them, then research would have a greater impact on teachers (McIntyre, 1998).

Greeno (1997) also gave ideas of what could be included to make participation in social practices successful, including

> *… the ability to give virtuoso performances, provide information for discussions, and compose reports or scientific papers that advance the functions of communities. Practices of individual exercise are often an essential part of the preparation of an individual to make these contributions (p. 9).*

A teacher's belief system influences how secondary teachers develop their practice. Researchers have analysed and theorised about the complex nature of teacher knowledge; and found that the beliefs and values that underpin teacher pedagogy are deeply ingrained and are usually the beliefs that teachers rely on and the beliefs are resistant to change (Barnes, 1992; Elbaz, 1983; Kennedy, 1997). Kennedy continued to say that giving teachers accessibility to research may not be enough, but research should be placed within conceptual reach of teachers to allow them to reconsider their prior assumptions and beliefs. A consideration of all these values and beliefs that together explain and influence teacher knowledge and teacher learning, demonstrates the reason that change in practice is such a difficult process.

Hoban (2002) asserted that in order for teacher learning and change in a teachers' belief system to occur, a teacher needs to make a long-term effort; take responsibility for his/her own learning; be reflective; believe

that teaching is a lifelong endeavour; and, work collaboratively with other teachers (also help other teachers to learn about their practice). This type of self-motivation seems to be intrinsically driven by the individual teacher.

Moreover, it has been found that an agent or catalyst for change is required to offer teacher's alternate viewpoints (Hoban, 2003) . McNamara (2002) found that engagement in *using research* and *doing research* were powerful enablers for professional learning. From various sources, it seems that the catalyst for teacher learning and change may vary, as it may be started:

- by conducting research (Cochran-Smith & Lytle, 1999; McNamara, 2002);
- by listening to other teachers' ideas in a professional community (Grossman, Wineburg, & Woolworth, 2001)
- in the form of reading of research articles (Bell & Gilbert, 1994); or
- by problematising teachers' current practice in terms of the outcomes for students (Timperley et al., 2007).

Although provision of these catalysts may be motivators, it is necessary that teachers have alternative options and the support to pursue the change therefore teachers need a powerful reason in order to engage with new information in sufficient depth that brings about change to their practice (Timperley et al., 2007). Successful teacher change is to be supported at many levels, from the individual to the organisation, so not only do teachers going through change require ongoing support, but also as the change process occurs the teachers' needs for support and assistance changes (Hall & Hord, 2011; Loucks-Horsley et al., 2010).

Thus, several considerations on both the individual teacher level as well as within school leadership for support are required to encourage and nurture teacher change. Effective professional learning (in school-based interventions) is largely associated with a supportive school leadership (Timperley et al., 2007). The writers explained that in many cases where effective learning took place, it was shown that leaders were involved with

developing a learning culture or ethos in the school, assisting with arranging of professional learning opportunities and providing an environment to support these and thus developing the leadership of others. The necessity of a supportive learning environment with opportunities was affirmed in research done by Hodkinson (2009) on teacher learning at work and the types of environments that are expansive as opposed to restrictive.

Disposition of individuals to teacher learning

Research done by Hodkinson (2009) suggested that teacher learning was varied and complex, but that the most effective ways of understanding and improving teacher learning were when there was a combination of the perspectives of learning as workplace participation and those of learning as personal construction. The research, carried out in England, was to determine how secondary school teacher learning occurred at work. The outcomes showed that the factors which had the most influence on the nature and effectiveness of the teacher learning were threefold; namely "the dispositions of individual teachers; the nature of local working cultures; and the impact of policy and regulation frameworks and interventions" (Hodkinson, 2009, p. 160). These factors resonate with what was found by Timperley et al. (2007) in terms of both the support required and the individual disposition of the teacher as learner. Hodkinson goes on to discuss how a teachers' disposition was found to orientate a person in a situation (for example an opportunity for learning at work) and thus influenced both their reaction to the situation and their actions taken.

In conclusion, teacher learning is complex and although teacher learning is essentially a highly individual process, it is shown often to be initiated and enhanced by collegiality and professional networks. Striving to improve teacher learning therefore requires consideration of a number of factors such as effective leadership, support at school and consideration of the individual disposition of teachers as learners.

2.6. Professional development

Although professional development and professional learning may be used synonymously in some literature, they are distinguished in this study. Professional learning is an all-encompassing term to communicate the internal processes by which individuals create professional knowledge, whereas professional development is defined as the formal or informal opportunities, processes or activities for teachers' professional learning; thus for teachers to enhance their knowledge, skills or attitudes; or to change instructional practices to ultimately improve student learning. (Borko, 2004; Guskey, 2003; Wallace & Loughran, 2003). In the subsequent two sections, informal and formal learning opportunities are distinguished and discussed as these apply to professional development.

Informal learning

Informal learning may include unplanned activities that do not have predetermined outcomes. Although the informal and incidental learning (for example from staff meetings) is not typically documented, it is nevertheless important to acknowledge the possibilities these informal occurrences offer for promoting professional learning (Timperley et al., 2007). A further example of informal learning is the additional reading and further searching for research findings done by teachers in their own time. The researcher of this study also desires to determine the way science teachers access this type of information informally or incidentally and how it impacts on their learning and their teaching practice. No studies could be found that documented informal learning of science teachers.

Formal opportunities

Formal professional development has been described as opportunities in which information is disseminated to teachers in order to influence practice and should therefore ideally involve professional learning (Timperley et al.,

2007). However, Loucks-Horsley et al. (2010) indicated that teachers have often reported that much of the professional development available is not useful to them, implying that teachers' professional learning is disconnected from their practice. Albeit the comment is made for professional development offered in the United States, it is not hard to imagine that the situation would be similar in New Zealand. For example, the most prevalent type of professional development offered, is unfortunately, also what is known to be ineffective, both internationally and in New Zealand, namely listening to inspiring speakers or attending one-off workshops, however, this rarely changes teacher practice sufficiently to impact on student outcomes (Timperley et al., 2007).

To begin to address this, in the Best Evidence Synthesis (BES) Iterative (Timperley et al., 2007) ninety-seven studies were analysed to determine what types of professional development and learning works, whom it works for and under what circumstances it works. In their analysis, the researchers found that teacher change had been successful and student learning can be impacted when teachers had occasion(s) to engage in effective professional learning and development. Effective formal professional development typically occurred over extended periods of time and had external providers involved to assist with making the content meaningful to teachers and also manageable within the context of their teaching practice. Therefore teacher engagement in learning encouraged teachers and provided teachers with opportunities to participate in professional communities. Moreover, effective professional development was consistent with current research findings and wider trends in policy.

Kelleher (2003) reflected on research that had clearly shown that for professional development to be effective it had to be embedded in teachers' work, helping teachers to think critically about their practice and develop new instructional strategies and techniques for assessment and to measure how new practices had affected student learning.

Furthermore, the content and the activities constructed for effective professional development are presented in detail in Timperley et al. (2007), but it was found that the content was more important than any particular activity. The theoretical basis needs to be understood by teachers and the application thereof to teaching if teachers are to effectively change teaching. As summarised by Timperley et al. (2007):

> *Professional development that led to sustained better practice had a focus on developing teachers' pedagogical content knowledge in sufficient depth to form the basis of principled decisions about practice. This knowledge needed to be combined with evidence-based skills of inquiry so that teachers could identify next teaching steps and test if changes to practice were having the desired impact on students. Participants needed the organisational support of their schools in terms of the evidence base, collective goals to aim for, and circumstances that continued to motivate improvement (p. xlvi).*

Wallace and Loughran (2003) supported this as they view the best professional development as the type that is locally managed and is linked with other discourse communities. Furthermore, it is more complicated than that, as discussed in the section on teacher learning, due to individual dispositions. This is supported by Timperley et al. (2007) as they discussed that there are diverse learning needs within any group of teachers, thus the learning should be tailored to the prior learning of the individuals, the teaching context and the skills required for those contexts, as well as to the disposition of the individuals and groups. As shown by research done in New Zealand, teachers can respond positively and apply the key message from professional development sessions to their classrooms, yet other teachers were negative "…and continued with habitual practices." (Timperley et al., 2007, p. 6).

In an attempt to simplify some of the complexities of research for physics teachers, Mikelskis-Seifert and Duit (2010), researchers in Germany in a project called *Physics in context,* supplied teachers with brief summaries

of research findings and theoretical perspectives (called the piko-letters). Furthermore it was found that support for teachers' thinking was provided through workshops, but the value attached to these piko-letters was only high if "teachers experience the value of these information in their daily work, namely if the letters were discussed in the sets [support workshops] and if teachers could use them in planning and performing instruction" (p. 303). In addition to this, the researchers found that incentives provided by the school, for example relief time to engage with the project and seriously reflect on new ideas, were a beneficial component of changing teacher instructional practice. Hence, the amount and excellence of training in workshops, and time to reflect proved to be the major factors for enhancing teacher learning in the project. This time for reflection will be discussed further in the section on reflective practice.

2.7. Reflective practice

History of reflection

Although it was Dewey (1938) that originally proposed reflection as a way of rethinking a problematic situation nearly eighty years ago, it was Schön (1987) that revived reflection five decades later as he distinguished between spontaneous reflection, termed *reflection-in-action* and more deliberate reflection termed *reflection-on-action*. Louden (1991) acknowledged that since Schön's influential work on reflective practice, teacher reflection has become invaluable in education and important in teacher education and teacher development. More recent literature suggests that teachers making investigations into their own practice, otherwise known as *self-study*, has advanced so rapidly that some writers consider it to be the most rapid growth area of teaching (Lyons, 2009).

The necessity of reflective practice for teacher learning

Killen (2007) considered that although there have been various approaches to reflection and criticisms of different views of reflection, the

common and ultimate aim of helping teachers to reflect is that “they not only question their own practices but also render problematic many of the aspects of teaching that are generally taken for granted” (p. 92) Similarly, in the McKinsey and Company report (Barber & Mourshed, 2007), teachers were called to “become aware of specific weaknesses in their own practice” (p. 27). The awareness included both of what teachers did and the mindset underlying it. Fullan (1993, 1999) contended that teachers will only begin to question their practice and think differently about teaching and learning if reflection occurs at all levels, namely the personal, group and organisational levels.

The influence of reflection on teacher’s accessing and using research findings is that as new experiences are encountered, which should often include research findings, these should be tested consciously and thus findings may have an impact on teacher knowledge and pedagogy. Lyons (2009) explicated Boud, Keogh and Walker’s (1985) view of reflective inquiry and discussed how teachers can make conscious decisions about their own learning if they are aware of the role of reflection in learning and how the processes involved in reflection can be facilitated.

Baird (1992) agreed that teachers’ reflection of their practice has been considered to be a foundation stone of professional development and more recently, professional development programme advisors like Loucks-Horsley et al. (2010) have found the role of reflection invaluable in promoting teacher learning.

Successful reflection requires skills that must be learned and reflection is usually a challenging undertaking for teachers and students (Lyons, 2009). If reflection is well developed and supported and also has meaning for the individual, it can serve a purpose in informing personal growth and change (Fox, White & Kidd, 2011), whereas teacher learning seldom occurs without these conditions. Wallace and Loughran (2003) illustrated this by giving an example of research done with teachers in schools that did not value or support critical and reflective practice, resulting in inadequate reflective practice and low morale for the teacher. Munby, Russell and

Martin (2001) add that the culture of schools must support, encourage, and reward reflection and experimentation by teachers in order to overcome "the challenges that school contexts present to the development of professional knowledge within teacher education" (p. 895).

Hoban (2002) detailed the role of a reflective cycle in professional learning declaring that "teachers need to understand how to make connections between various inputs to enhance their learning" (p. 124). He continued to say that teachers need to discover their own connections about learning and this is enabled by teachers' critically reflecting on their experiences and thus actively examining patterns of change. In light of this study, teacher inputs and experiences may include research findings accessed through for example reading journals or gained from professional development sessions.

The complexities of change through reflection were further demonstrated in a recent study undertaken by Khoo and Cowie (2011) in witnessing a change in teacher practice as a result of a negotiated intervention strategy, where the researchers state that:

> *… reflective conversations with the teacher revealed the complexities of working with an experienced teacher to reconceptualise and transform his pedagogical practice and the intellectual, social and emotional changes he faced (p. 345).*

Experienced teachers and early career teachers

Research literature has shown that effective teaching requires expertise rather than just experience (Munby et al., 2001). One of the most important aspects of exceptional teachers is that they are committed to continually seeking to extend subject knowledge and teaching expertise in all areas pertaining to the subject they teach as well as to teaching, learners and learning (Killen, 2007). The writer goes on to say that exceptional teachers are reflective teachers that critically view all their teaching practices and accept that practices should be questioned and, if

necessary, changed. Thus, although experience is necessary for teachers to have a basis for reflecting and refining teaching strategies, experience is not a sufficient factor for good quality teaching. It follows from this argument that the necessary factor for exceptional teaching is commitment to extending knowledge that is evidence-based, i.e. involves accessing and reading research findings.

Alternatively, Killen (2007) pointed out that reflection may be more difficult for early career teachers, mostly because the mental processing capacity required for reflection may "be taken up just thinking about how to survive and perform" (p.91). In addition to the mental processing required for deep reflection to occur, early career teachers still require an experience basis for reflection as discussed above.

In conclusion, albeit a demanding and difficult undertaking, reflection is a key condition for success in teacher learning and hence in changing teacher pedagogy and practice. Teachers, in becoming aware of reasons for their teaching pedagogy and focussing on understanding and implementing change are able to be better lifelong learners and thus more effective teachers.

2.8. Summary

In this chapter educational research and its influence on science teachers was explored. An historical nature and influence of educational research and its alignment with both teacher learning and professional development was considered. The contrast between the desire of educational researchers to impact teaching and the limited impact that research has had on teaching was discussed. Furthermore it was shown that supplied professional development has not frequently been based on the best available research evidence.

The constructivist learning model that influenced this study was expounded and related to teacher knowledge and teacher learning. The

complex elements required for substantial change in teaching pedagogy and practice was examined and favourable conditions to nurture and promote teacher learning discussed. Relevant aspects of both informal and formal professional development were considered as relating to effective teacher learning. Finally, a brief discussion of the necessity of reflective practice for effective teacher learning was presented with the primary factors that affect reflective practice also considered.

Chapter three, which follows, considers the methodology of this study and introduces the research design for this investigation into secondary science teachers' use of research findings to inform their teaching.

Chapter Three

Research methodology

3.1. Introduction

In this chapter, general methodological ideas are considered and arguments presented for the chosen methodology for this inquiry. Subsequently the research methods are expounded in light of the chosen methodology. Finally the origin and background for the researcher's chosen research design for this study will be explored and justified, including ethical concerns and how rigour in the design was ensured.

3.2. Methodology

3.2.1 Paradigms

Mackenzie and Knipe (2006) argued that the choice of methodology, or paradigm "sets down the intent, motivation and expectations for the research (p. 194). Traditionally, some authors view research traditions as either qualitative or quantitative. However, Guba and Lincoln (1994) hold the view that methodology or paradigms, and not methods, are this umbrella. They argued that "questions of method are secondary to questions of paradigm" (p. 105). Thus, theoretically, any methods can be used in any paradigm.

Although there are many texts, providing various opinions of the number of paradigms and divisions thereof, a generalised idea is that three major paradigms for inquiry exist: the positivistic view, interpretative inquiry and the paradigm of critical theory. Ontological and epistemological viewpoints of the researcher are significant elements in determining the methodology and methods for a research area. Ontology relates to how things exist in the social world, whereas epistemology relates to "the question of *knowing* and the nature of knowledge" (Hitchcock & Hughes, 1995, p. 19)

In the positivistic view, researchers are “the analysts or interpreters of their subject matter” (Cohen, Manion, & Morrison, 2007, p. 10). Guba & Lincoln (1994) explained that in positivism, ontology asserts realism, where an apprehendable reality is assumed and the researcher claims an “objective detachment” (p. 108) in order to study the object without influencing it. The researcher seeks to control certain variables to discover causal relationships therefore the researcher usually prefers an experimental design using quantitative methods (Giles, 2011).

Borko, Liston and Whitcomb (2007) defined interpretative research to be “at its core, a search for local meanings” (p. 4) aiming for particularisabilty, as opposed to the generalisability crucial for positivist inquiries. There is a search to understand experiences and perspectives of others, suggesting that reality is socially constructed and localised to the context (Mackenzie & Knipe, 2006). The subjective researcher and researched are assumed to be interactively linked (Guba & Lincoln, 1994). The social reality of the person may be multiple and perhaps conflicting and may even change as information is gained.

Critical theory is a blanket term used to denote several alternative paradigms, such as Feminist, Postmodernist (Guba & Lincoln, 1994) and incorporates others, for example the Maori perspective (Davidson & Tolich, 2003). The focus of critical inquiry is change-oriented; to change an issue or a situation or a context by intervention, emancipation or empowerment (Giles, 2011).

This study seeks to explore the thinking of teachers and how research findings have changed their teaching and their consequential learning. This study considers that science teachers’ knowledge and dispositions to using research findings have been constructed over time, developed by social and experimental encounters, and may also be local to context and specific to culture. Thus an interpretative paradigm was selected as the most suitable methodology to allow for interaction between the researcher and participant in order to gain an understanding of the beliefs, perceptions and realities of the science teacher. The interpretative

researcher aspires to exemplify the individuals' perceptions of their realities. The data from a number of individuals is then used to develop a theory that may shed light on people's activities under comparable circumstances and contexts (Borko et al., 2007).

3.2.2. Quality of interpretative research

The quality of interpretative research is critiqued by "credibility, applicability, transferability, dependability and confirmability" (Borko et al., 2007, p. 5).

The interactive nature of the inquiry is important to this research. The matter of subjectivity is not disregarded but believed to be an obligatory requirement to investigate the constructions held by individual teachers. Subjectivity on the part of the researcher is acknowledged and the implications of the researcher's choices as both interviewer and writer are to be transparent. Bryman (2001) explained that the term 'reflexivity':

> *…carries the connotation that social researchers should be reflective about the implications of their methods, values, biases, and decisions for the knowledge of the social world they generate (p. 470).*

The researcher is thus implicated in the creation of knowledge through the standpoint that the researcher takes in relation to the interviewees and through the ways in which an account is conveyed in the form of the thesis text. Eisenhart (2006) also voiced her concerns about transparency in interpretative research, suggesting that the reader of research is required to place trust in the researcher. This means that the researcher must be extremely self-aware and self-reflective, and show this in the process of interpreting and representing data in the study.

Mackenzie and Knipe (2006) emphasised that the downfall of interpretative research is questionable transferability, or the "lack of shared conceptual frameworks and designs" (p. 5), which makes it hard to

compare and contrast findings between studies. The researcher recognises that to produce quality research there is a need for transparency in interpreting and representing data, and to provide reasons for decisions made every step of the process. In terms of dependability, the researcher has kept complete records at all phases of the research process, including transparent notes, interview transcripts, data analysis decisions and explained these as best as possible throughout the analysis of data and discussions in chapter five of this study.

3.3. Research methods

Interpretative researchers may make use of methods such as observations, interviews and document analysis, such as journals (Borko et al., 2007; Mackenzie & Knipe, 2006). Thus, the methods for interpretative inquiry usually rely on qualitative data gathering, although some quantitative methods may be incorporated.

The methods selected to be best suited to this investigation were questionnaires containing both closed and open questions and semi-structured interviews.

3.3.1 Questionnaires

Questionnaires are one method of collecting survey information as these are practical for collecting structured data that is often straightforward to analyse (Cohen et al., 2007; Mutch, 2005). A questionnaire is useful when:

- information is sought from a large number of people in a particular group and
- the information sought is not complex
- the researcher is certain that a questionnaire will produce the type of information required in the study (Hinds, 2000).

However, Hinds (2000) warned that designing a good questionnaire requires skill and can be a challenging technical activity, it is a time-consuming process, and careful planning is crucial. The preparation includes writing a covering letter, composing a clear and carefully constructed questionnaire, then a phase required for piloting and making amendments in preparation for the final distribution and return (Hinds, 2000). Although respondents might be strongly encouraged, they cannot be coerced into completing a questionnaire (Cohen et al., 2007). The respondent's cooperation is voluntary, thus the letter and questionnaire should outline the purpose of the study, be courteous and user-friendly. Bryman (2001) also emphasised the importance of clear, uncluttered presentation of questionnaires to assist in increasing the response rate. The quantity, format and types of questions should all receive careful consideration in order to avoid ambiguity. Cohen, Manion and Morrison (2007) give greater detail of a sequence to follow when planning a questionnaire, thus:

- determine the purpose or objectives of the questionnaire;
- elect the population and the sample, in order to include questions about their characteristics;
- generate the topics, constructs, concepts or issues to be addressed and data obligatory in order to meet the objectives of the research;
- resolve the types of measures, scales, questions and responses required;
- compose the questionnaire items; and
- ensure that each issue stated has been addressed using several items for each issue.

This plan has several sub-components within each stage, but these are dealt with in greater detail in Cohen, Manion and Morrison (2007). Questions can be designed as either open of closed questions depending on the information sought. Closed questions provide pre-determined categories and open questions allow respondents to word responses in their own way (Hinds, 2000; Mutch, 2005).

Piloting follows the planning stage and is important to check that questions are clear; to make certain that leading questions are avoided and to ensure respondents don't misinterpret questions (Hinds, 2000). Critical feedback must also be sought in order to determine suitable layout of the questionnaire and changes made where necessary (Mutch, 2005).

3.3.2 Analysis of questionnaires

Hinds (2000) defined quantitative data as "those types of data that can usually be reduced to numerical form" (p. 81) where the analysis entails manipulation or a statistical test. Two types of analysis can occur;

- descriptive analysis that aims to describe the data but not "generalise beyond the particular group investigated" (Mutch, 2005, p. 164); and
- Inferential statistics that questions the data or tests hypotheses (Hinds, 2000) in order to generalise to the population from which the sample was selected.

Bouma and Ling (2004) suggested that data should be organised by first selecting categories, then coding the data and finally determining a method to present the data. The categories selected depend on what is being measured and the data can be divided into nominal, ordinal, interval and ratio measurements. A basic statistics programme like SPSS may be used to enter the data into data entry sheets once the variables are labelled according to the options on the questionnaire (Morgan, Leech, Gloekner, & Barrett, 2007). After entry, descriptive statistic tests must be done with the data to examine accuracy of data input and subsequently further descriptive tests or inferential tests can be completed to present the data in a useful form (Morgan et al., 2007).

The open questions in the questionnaire can be analysed using thematic analysis by identifying themes, ideas or patterns of belief that are found in the answers given by respondents (Mutch, 2005). The textual elements

are compared and contrasted, establishing linkages and relationships in the data. A qualitative data analysis method using general purpose software tools can be used to sort into possible categories, as explained by La Pelle (2004).

3.3.3 Semi-structured interviews

An interview is described by Burns (2000) as “a verbal interchange, in which an interviewer tries to elicit information, beliefs or opinions from another person” (p. 423). The definition given by Kvale (2007) is that an interview is seen literally as an *inter-view*, or an exchange between two persons conversing about a theme of common interest. This definition makes interviewing more of an interpersonal encounter, not simply an exercise to collect data. It implies that a rapport is to be built between the people involved, with the aim to gain richer interpretations of a person’s perceptions of their reality. Gray (2004) pointed out that the interview is beyond normal conversation as a great deal of attentiveness and observation is required, listening to the words but also the “tone and delivery of the dialogue” (p.226) and observing of non-verbal cues.

A range of different forms of interviews have been identified, however broadly three are categorised here; namely structured, semi-structured and unstructured. Burns (2000) argued that of the three forms, only the latter is a qualitative method, because only unstructured interviews “permit access to individual meaning in the context of ongoing daily life” (p. 388). However, other educational research experts regard both semi-structured and unstructured as qualitative methods. For example Barbour (2008) also argued that in qualitative interviewing “we are not seeking to measure attitudes or specify the exact nature of relationships between variables, but …. eliciting in-depth accounts from people with room for them to select which aspects they wish to emphasize” (p. 115).

A semi-structured interview is less rigid than structured one, and allows depth to be achieved by probing the interviewee to expand on responses. For this reason, Hitchcock and Hughes (1995) suggested it may be preferred by researchers in education. As the researcher listens closely to the interviewees' responses, the interviewer is able to have more freedom to ask questions pertinent to the study and probe for additional information. Furthermore, this means that the results are contextual findings and not all-encompassing generalised statements (Maykut & Morehouse, 1994).

Cohen et al. (2007) suggested that interviews could be used for a number of purposes: firstly they can be used to gain information about knowledge, values, attitudes and preferences of people. Secondly, interviews can be used to test hypotheses or create new ones. Thirdly, they suggested they may be used to support or triangulate other methods for example, after a questionnaire, a select number of interviews may be done to explore responses in more depth.

One advantage of using interviews, compared with written data gathering is that "reading ability is not a concern" (Mutch, 2005, p. 126). Additionally, interviews enable "multisensory channels" (Cohen et al., 2007, p. 349) of communication for data gathering. The interviewer can pursue complete answers and gain profound explanations for complex issues. Relatively new, yet worth mentioning, is the *e-interview*. However, using a combination of visual, auditory and/or textual basis (such as Skype and/or emails) has implications for the claims that can be made. For example, Dowling and Brown (2010) considered that a respondent may read and edit an email, thus answers may not be their initial response. However, there are some other negative aspects to interviewing, which I will explore.

In conventional interviews, skills that may not be characteristic of the interviewer may need to be developed to provide effective interviews. Interviewers may differ in personality and approach. Van Kammen and

Stouthamer-Loeber (1998) developed a process for training interviewers, showing that many aspects to interviewing may need to be learnt. However, Cicourel (as cited in Hitchcock & Hughes, 1995) argued that the results are influenced by interpretations and judgements, on the part of the interviewer, regardless of training. Conversely, both Barbour (2008) and Dowling and Brown (2010) agreed that most of the problems of interviews can be overcome by training, piloting interviews and practising the techniques, such as questioning and prompting without leading, establishing rapport and timing.

Interviews are expensive and time consuming for all involved. Work done in the early 1980's for the Learning in Science Project, led Bell & Osborne (1981) to publish useful practical guidelines for interviewers. One warning was that interviews require intensive concentration, thus they advise researchers not to have a number of interviews consecutively. Upon reflection, although interviewing and specifically analysis requires specific skills and is a time-consuming method, it also has many benefits, trying to gain better insight into the reality of teachers. This method can contribute significantly to in-depth data gathering for this study.

3.3.4. Transcription and analysis of semi-structured interviews

Time taken for transcribing of interviews is extensive, especially if linguistic features are included (Delamont, 1992). Data organisation and analysis are also time consuming and often prove difficult, especially for unstructured interviews. In addition, there is also the danger of bias creeping into data analysis. However, Gray (2004) recognised that this can be dealt with if the researcher is transparent about recognising signs of bias, thus constantly checking attitude to the interpretation of the data. The analysis of the data presents further complexities.

The analysis of interviews requires the researcher to "find patterns within those words (and actions) and to present those patterns for others to inspect while at the same time staying as close to the construction of the

world as the participants originally experienced it" (Maykut & Morehouse, 1994, p. 18). Best and Kahn (2006) gave a summarised three step process to analysing data; first organising the data, then the description of "pertinent aspects of the study" (p. 270) and the third step is interpretation. However, Delamont (1992) and Bryman (2001) have a more descriptive process of analysis, thus it will be explored simultaneously.

Delamont (1992) advised that in analysing, it is essential to read the interview transcripts three, four or more times, whilst recording "analytic memos on analysis" (p. 151), on the first reading and again on each subsequent rereading. These 'memos' are then coded into themes or ideas. These themes and ideas are chosen according to the interest of the research question. Using a systematic exploration of the information, patterns (and irregularities) are identified. Bryman (2001) also suggested that the codes (themes) could be utilised to further develop questions in subsequent interviews. The explanation sounds very much like one used in grounded theory, which will be discussed in the research design.

Once patterns are established, it enables contrasts and "potential generalization" (Delamont, 1992, p. 152) to be identified within the themes or ideas. The next step is that data needs to be checked for internal reliability and consistency. Triangulation taking place at the analysis stage is done by revisiting the transcribed data as ideas are developing, to ensure that the original transcription supports this idea in more than one way. The researcher can proceed on to the final step of generalising and theorising, once all of the above steps are complete (Delamont, 1992). The outline of this process will be discussed in further detail in the research design.

3.4. The research design

This study investigates how secondary science teachers obtain and utilise published educational research material, how they engage with the material and how teachers perceive this has shaped their pedagogy and practice as science teachers. The focus of this study is how science teachers perceived how engagement with research has shaped some aspect(s) of their learning and practice.

Reflective practice is recognized as an important part of the teacher assessing the effectiveness of his/her own teaching. The researcher assumes that the reflective teacher will be able to identify important precursors to change, such as knowledge gained from research findings, and explain the way they have developed and changed their content knowledge and pedagogy.

3.4.1. Considerations in the design

In designing the study, some important factors had to be considered:

- Difficulty in obtaining views from a sufficient number of science teachers, preferably from a variety of schools in various geographical locations.
- Teachers are already busy professionals and their involvement in the questionnaire and interview could not add significantly more demands to their workload.

Taking these factors into account, it was most cost effective to attend a conference where a number of science teachers from various geographical areas were assembling. The questionnaires had to be kept concise and timing had to be reasonably short. Hence the questionnaires were piloted by a group of science teachers at a local secondary school and a few colleagues at the University to ascertain accuracy of questions and time taken to complete the questionnaire. The subsequent semi-structured interviews with voluntary teachers were conducted at a later

date, were kept to no more than half an hour in most cases, and the researcher was flexible as these were done at the time of day or evening, week or weekend that best suited the individual teacher.

3.4.2. Data collection

The participants in this study sample were a convenience sample. The participants were all attendees at a chemistry teachers' conference, from across New Zealand, and from a variety of integrated, state and independent schools. The demographic data of the participants is given in chapter four.

As shown in Appendix G, the collection of data was undertaken between July and November 2011. A letter was sent to the conference convener (see letter Appendix A) in May of that year to ask permission for this study to be presented at the conference. Before they opted to participate, the participants were briefed on the nature and requirements of this study, in two ways; a covering letter on the questionnaire (placed in each delegate's information pack) and a brief five-minute slot in the proceedings was granted by the convenor for a PowerPoint presentation on the third day of the conference. The researcher introduced the intention of the study and expressed appreciation for any voluntary involvement. It was found that this brief presentation and personal approach to teachers yielded more returns than on the first two days of the conference before the presentation was given.

The research process had two phases for data collection:

First phase: The questionnaire administered at the chemistry teachers' conference is aimed at taking no longer than 15 minutes to complete. At the end of the questionnaire each participant was invited to take part in a further interview. The participant could decline to participate further or provide contact details in order to take part in a semi-structured interview at a later stage.

Second phase: A letter of information with a consent form attached was sent to participants who further volunteered to be part of the research (see appendix B). Semi-structured interviews, many using Skype nationally were used where interviewees were in further geographical locations. Each interview was recorded and saved to the researcher's computer hardrive using the 'Pamela' software. The aim was to be able to interview 5 to 10 of the participants in a semi-structured interview of no longer than 30 minutes. Interviewees were originally planned to be chosen using simple random sampling, however only nine of the thirteen possible interviewees that had responded to follow-up emails were interviewed in the end.

The reason for using semi-structured interviews was twofold: to clarify answers given in the survey and to allow more detailed questioning and answers to relevant issues that may not have been able to included in the survey, and questions that had developed as a result of answers given in the questionnaire.

3.4.3. Analysing data in this study

Using SPSS, descriptive analysis was done on the closed questions in the questionnaire. The textual answers to open questions were analysed using thematic analysis and a general software tool (La Pelle, 2004) as described in a previous section. A variety of results from the tests showed trends and raised more questions that could be asked in the semi-structured interviews.

In analysing the interview data, the researcher followed the process for grounded theory (Bryman, 2001) or thematic analysis as outlined by Mutch (2005), and included parts of the process as outlined by Delamont (1992) as discussed above.

The first step of the process involved transcribing each interview within a week and making notes/memos while the interview was still fresh in the

interviewer's memory. As memos were coded into themes or ideas, codes were applied to the data and the initial phases of analysis occurred for the first few interviews. Thus further questions could be added to the semi-structured interview list in order to try to gain richer data in subsequent interviews. This process was guided by interviewer notes and memos that became apparent as the researcher was transcribing all the interviews and whilst reading through transcriptions. Once all the interviews were conducted and transcriptions complete, the researcher read through each of the nine interview transcripts several times, highlighting parts of interest (memos) and applied further codes to the transcripts.

Furthermore, from the second step of the analysis process, grounded theory was used. This started with reviewing codes to determine recurring concepts or broad principles. As explained by Bryman (2001), a category often "subsumes two or more concepts" (p. 392). Various commonalities were identified to code concepts into categories (unifying ideas), however concepts unique to individuals were also noted.

Patterns were sought to group similar ideas within the transcript, and resultant diagrams similar in appearance to a mind map, to roughly group concepts and themes together into categories. These rough category diagrams (see Appendix C) were drafted for each interview transcript and were then inspected for similarities and differences between concepts identified for one interview participant with concepts identified for previous interview participants. Comparing three rough category diagrams showed emerging concepts that were common to a number of participants. Using the more common themes and concepts from a number of participants, a more generic skeleton theme diagram could be constructed (see Appendix D).

Subsequently, having identified major themes in the generic skeleton diagram, all the essential information was placed back onto the skeleton theme diagram with one used for each interviewee transcript. This was done by reassessing a combination of the rough category diagrams and the original transcripts, adding in short quotes and page numbers in order

to find original phrases in context as required (see Appendix E). Once again two or three completed theme diagrams were compared and contrasted so that properties of a category could better be recognised. Hypotheses or “initial hunches about relationships between concepts” (Bryman, 2001, p. 292) were explored for those which were more apparent and links sought between categories. Of value at this point were reflections on identified concepts and themes; checking for consistency between those identified and examining accuracy with the original transcripts, thus triangulating the themes in the analysis, as was suggested by Delamont (1992).

In addition to these rough category and common theme diagrams, a matrix (coding) table was drawn up to include all the common concepts and themes across all nine interviewees with page references to original transcripts (see Appendix F). The resultant three-page matrix coding table provided both a comprehensive summary of all the concepts and themes identified as well as unique ideas for all nine interviewees. The matrix coding table also contained the page number references for wording in the original transcripts, hence the tables became the most frequently accessed item in the analysis process, as it was used extensively as a ‘checking’ system to ensure that all concepts, themes and exceptions were covered in the analysis.

The third step of the analysis process involved interpreting the findings and reflecting on the importance of the findings. A number of emerging key hypotheses could be identified at this point.

3.4.4. Ethical concerns

Viewing the whole process of interviewing and analysis, ethical concerns had to be considered in light of relevant Ethical conduct regulations (University of Waikato, 2008) and in line with further literature.

Informed consent

As mentioned earlier, access to participants was via a letter and questionnaire included in the information pack which was supplied to delegates at a conference. A brief presentation was also given at the conference programme to explain the study and express appreciation for any participation.

The questionnaire included a cover letter explaining the aims of the study and requesting informed consent for the information provided in the questionnaire. Participants were required to sign the 'participant consent form' attached to the cover letter (see appendix A). In addition, interview participants were required to complete an additional consent form.

Avoidance of potential harm

In approaching potential participants, Barbour (2008) suggested that the researcher should consider implications for participants in becoming involved , e.g. time demands, how convenient the chosen setting will be, how participants anonymity can be ensured (e.g. pseudonyms), discussing "mechanisms for data sharing" (p. 78), and reducing harm or distress that could result from involvement in the research. The potential benefits both to the potential participants and to the worthiness of the whole study should also be mentioned, however, taking care not to make promises that cannot be fulfilled. The researcher needs to explain that participation is voluntary and that the participant has the right to withdraw. In addition, the assurance of confidentiality and participant safety should be explained. Bell (2010) added that the researcher should supply information in advance for potential participants with time to "read and consider the implications" (p. 46). In addition, written informed consent for an interview must be obtained from each participant.

Finally, the interview should end on a positive note (Van Kammen & Stouthamer-Loeber, 1998), giving an opportunity for the interviewee to reflect on the interview, thus hopefully leaving the participant with a

positive impression of the research. Gray (2004) agreed that even if the data gathering was not as useful as hoped, the interviewer should thank the interviewee for their help, time, insight etc.

Finally any further contact with participants was made only if participants had chosen to supply details and be involved in an interview. Thirteen participants that volunteered to be interviewed were sent an email to invite them to choose a date, time and venue to suit them, for the interview. Nine of the thirteen teachers responded. In seven out of the nine cases a video and audio Skype interview was used and recorded using 'Pamela'. One interview was a face-to-face interview and one was a telephone interview, with both audio recorded.

The teachers' involvement in the study questionnaire and interview was voluntary. If anything, the questions were intended to complement or enhance the teachers' reflective practice. Potential participants had the right to decline at the conference as half of the conference delegates elected not to complete the questionnaire. Teachers were informed that they could withdraw from the interviews at any time and decline to answer particular questions in the interview. Data that the teacher had provided in the questionnaire and that had been analysed prior to a withdrawal would be retained in the study. Interview data that the teacher had provided in the interview and had been analysed prior to withdrawal would be retained in the study.

Confidentiality and anonymity

Through the use of pseudonyms, all participant teachers' names were kept confidential. This was stated in the letter regarding informed consent on the front of the questionnaire. All names were detached from data, including consent forms, audio files and transcripts. Pseudonyms were used to code information throughout the analysis and discussion. Information gathered from participants remained confidential and was stored securely by the researcher at her home and would be for at least

five years. Recorded interview data was downloaded to a secure location on the researchers' computer with security access codes required to access information. The computer is a desk-top computer in the researcher's home study.

Participants own their raw data, hence may receive information as requested, but only had access to their own questionnaire in the interview, and no access to other participants' questionnaires. The researcher owns the data analysis. Teachers received copies of their own transcribed interviews to review, but did not have access to transcriptions of interviews with other participants. The participants were able to view and accept or make necessary corrections within two weeks of receiving the transcript.

Teachers that provided contact information in the questionnaire (including those that were interviewed) received a copy of the final summary of the research findings when the study was complete. Participants were informed that there was a possibility that findings may be disseminated through seminars, conference presentations and journal articles in the future and this was made clear to the participants on the consent form.

Rigour in the research design

To ensure rigour and trustworthiness in this study, common social science research procedures of validity and reliability were undertaken. Validity "is that quality of a data-gathering instrument or procedure that enables it to measure what it is supposed to measure" (Best & Kahn, 2006, p. 289). However, to the qualitative researcher validity relates to whether the design of the research allows conclusions to be drawn about the sample of the study and the extent to which effects can be generalised beyond the research context (Burns, 2000). In this study field-testing the questionnaire with a group of science teachers at a local secondary school ensured validity.

Reliability may be defined as the "repeatability of the process" (Dowling & Brown, 2010, p. 148). Reliability was achieved by consistency in the data

collection methods. In the interpretative inquiry, trustworthiness, validity and reliability will each be 'judged' on their own requirements for quality. Although Bryman (2001) suggested that trustworthiness is the more appropriate measure to use in qualitative research.

Furthermore, Borko et al. (2004) consider that the quality of interpretative research is critiqued by credibility, dependability, confirmability and transferability which all confirm trustworthiness. Credibility is attained through representing multiple realities in a feasible way. Dependability portrays research with integrity and includes the keeping of accurate records at all phases of the research process. Confirmability ensures the researcher reports actual data that emerged from the study. Transferability in research is the transparency of context so that the reader is able to determine the relevance of the study to other contexts. In this study dependability and confirmability were established by member checks or respondent validation. Transferability was ensured by providing sufficient rich accounts of the details of the context, enabling the reader to make judgements about the prospect of transferability of findings to other situations.

Bryman (2001) explained that triangulation "entails using more than one source of data in the study of social phenomena" (p. 274). Triangulation helps to eliminate bias and increases trustworthiness of research. In this study both a questionnaire and semi-structured interviews were used in the data collection methods to ensure the accuracy of findings. Subsequently the interviews recorded on 'Pamela' were transcribed and data confirmed with interviewees. In addition, findings were cross-checked, to compare and contrasting findings from both qualitative and quantitative data collected. In summary, triangulation in this study was satisfied by collection of data from different sources, use of a variety of data collection methods and the combination of qualitative and quantitative approaches.

3.5. Summary

This research design was guided by the ontological and epistemological underpinnings of the interpretative paradigm. The aim of this study was to investigate the knowledge, thinking and perceived learning of teachers as constructed by social and experimental encounters in their context and in relation to research findings. It was decided that using the interpretative paradigm to construct the interaction to gain this information was the best way forward.

The qualitative inquiry was chosen as it approaches the research questions (see chapter 2) in a way that involves in-depth exploration of teachers' experiences, their reflections and factors that they perceive affect them in using research findings. The methods chosen and protocols followed incorporated suggestions in the literature on qualitative inquiry for making research valid, reliable and consistent.

The chapter following will show the data as analysed and presented in two phases, first the questionnaire will be analysed using descriptive statistics and thematic analysis and secondly the interviews will be analysed using grounded theory analysis.

Chapter Four

Analysis of data

4.1. Introduction

This chapter describes the findings of the questionnaire data and semi-structured interviews that were developed to answer the research questions. The first section reports on the findings from the thirty five questionnaires and these findings are further complemented in the second section with data reported from the semi structured interviews with nine teachers who had initially also completed the questionnaire.

The final section provides a summary of the data analysis.

4.2. Analysis of questionnaire data

The questionnaire (see appendix) was administered to approximately 70 science teacher delegates at a chemistry teachers' conference at which 35 conference attendees voluntarily completed the questionnaire. The questionnaire data was investigated to determine codes for Section A and B of the questionnaire and the data input into a statistical analysis programme. Using a simplified data analysis method as outlined by La Pelle (2004), the answers from the open-ended questions in section C of the questionnaire were typed into a word processing programme (Microsoft Word) and themes sought to code the answers. Various output combinations were then sought from various parts of the questionnaire and some themes identified.

4.2.1. Demographic characteristics of participants

Section A of the questionnaire dealt with data related to the teachers' professional experience, such as years of experience and position held at the school.

Years of teaching experience

The respondents gave the actual number of years of their teaching experience, but for the purpose of analysis the values were categorised into less than five years, then more than five but less than ten years experience and so on.

Table 4.1. Years of teaching experience for science teachers

Teaching experience in years	Frequency (n=35)
30 + yrs	7
20 to 29 y	7
10 to 19 y	6
5 to 9 y	7
Less than 5 years	8

The results showed a balanced spread of teachers experience in these categories (see Table 4.1). Of the 35 respondents, there were a similar number in each category for the number of years of teaching experience as shown in Table 4.1.

Gender

Of the 35 respondents, fifteen were male and twenty were female, hence there was a fair representation of each gender in the sample.

Classes taught

Due to the convenience sample used (teachers at a teachers' conference), all except one of the science teachers taught senior chemistry teachers as well as a few junior science classes and year 11 science. However, for recording purposes, only the highest level of teaching for a respondent was noted in Table 4.2.

Table 4.2. Highest level of classes taught by science teachers

Highest level of classes taught	Frequency (n=35)
Year 11	1
Year 12	4
Year 13	28
Missing	2

Position and Responsibilities

The questionnaire asked participants to state their position(s) in the department(s) at their school. In a second question, it also asked 'do you hold responsibility for a specific area within the science department? Please provide a brief overview of the activity or outcome associated with this responsibility'. Of the 35 respondents, 15 had no position of responsibility beyond teaching science but a total of 19 had further responsibilities in the science department, namely 7 as head of the science department (which in some cases also included head of chemistry), 10 as head of chemistry (HoD) OR teacher in charge of chemistry at the school and two as "TiC" or teacher-in-charge of junior science as shown in Table 4.3. Furthermore, there was one deputy head who also taught some senior science.

Table 4.3. Position at school for science teachers

Position (TiC = Teacher- in-charge; HoD = Head of Department	Frequency (n=35)
Science teacher	15
TiC junior science	2
HoD science and PD co-ordinator	1
HoD Science	6
HoD Chemistry	10
Deputy principal	1

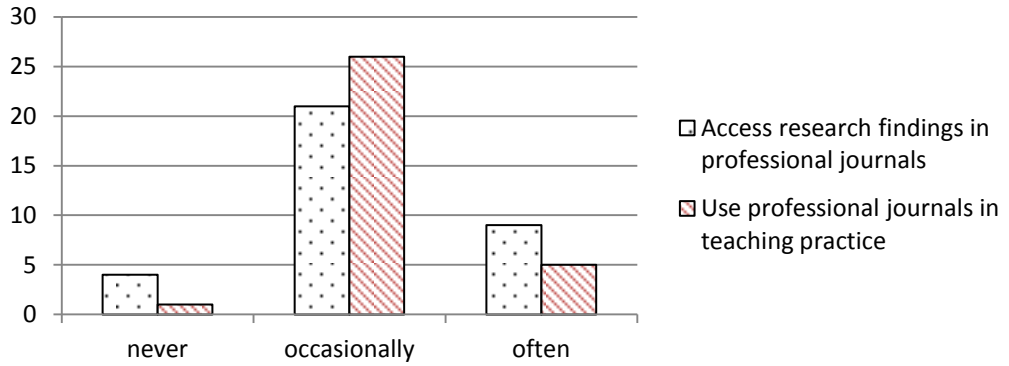
4.2.2. Types of educational research accessed and used

Section B of the questionnaire sought teachers' opinions about their access and use of educational research. The questionnaire listed five ways in which research findings are disseminated; namely through professional journals, conference papers, the internet, through organised professional development sessions and through school learning communities. In a tabular format, the respondent was asked firstly whether or not they had access to each of these (yes or no), secondly, the regularity with which they accessed these sources (using a Likert scale – often, occasionally, never) and thirdly, the frequency with which the information was used in their teaching practice (using the Likert scale - often, occasionally, never).

Accessing Professional Journals

Professional journals were listed as the first way in which research findings are disseminated. All 35 respondents answered the first part of the question, 'Do you have access to professional journals?' with 33 that answered yes and 2 that answered no. The second and third parts to this question stated: 'Do you access the research findings in professional journals? Do you use the information in your teaching practice?' However, three respondents did not answer all three of the questions, so they were excluded from further analysis: Of the 32 respondents that answered this question fully, 31 answered yes and 1 answered no. By far the majority said that they occasionally accessed professional journals and occasionally used the information in their teaching. Eight accessed the information often and four of these teachers often used the information in teaching. Figure 4.1. shows how similar teachers' answers were for either choosing occasionally and often in each answer.

Figure 4.1. Frequency with which research findings in professional journals are accessed and used (n=32)



However, when this data was tabulated to compare it to the hours per month that each teacher said that they read research findings, the term 'occasionally' proves to be ambiguous, taking on different meanings for different teachers. Table 4.4. below shows seven, three and seven teachers indicated that they read for less than half an hour, between half an hour and an hour and between one and two hours respectively per month. In addition to this, as shown in Table 4.4., two teachers indicated that they accessed journals often, yet reported that they read less than half an hour of research findings per month.

Table 4.4. Regularity of access to professional journals versus hours per month spent on reading research findings (n=34)

		Hours Per Month Spent Reading Research Findings				
		none	less than half hour	half to 1 hour	one to two hours	two or more hours
Access professional journals	never	0	3	0	1	0
	occasionally	1	7	3	7	3
	often	0	2	0	1	6

The disparity is even greater when compared with how regularly teachers used professional journals in their teaching, as shown in Table 4.5. Conversely the teachers that indicated that they spent more time reading and also indicated that they accessed professional journals often and used in their teaching often showing a stronger correlation.

Table 4.5. Regularity of professional journals use in teaching versus hours per month spent on reading research findings (n=32)

		Hours Per Month Spent Reading Research Findings				
		none	less than half hour	half to 1 hour	one to two hours	two or more hours
Use professional journals in teaching	never	0	1	0	0	0
	occasionally	1	10	3	9	3
	often	0	0	0	0	5

During the interviews, respondents were asked to provide more information about these points and identify what specific research findings from professional journals they had found most useful. Those findings will be discussed in the interview analysis section 4.3.3.

Accessing Conference Papers

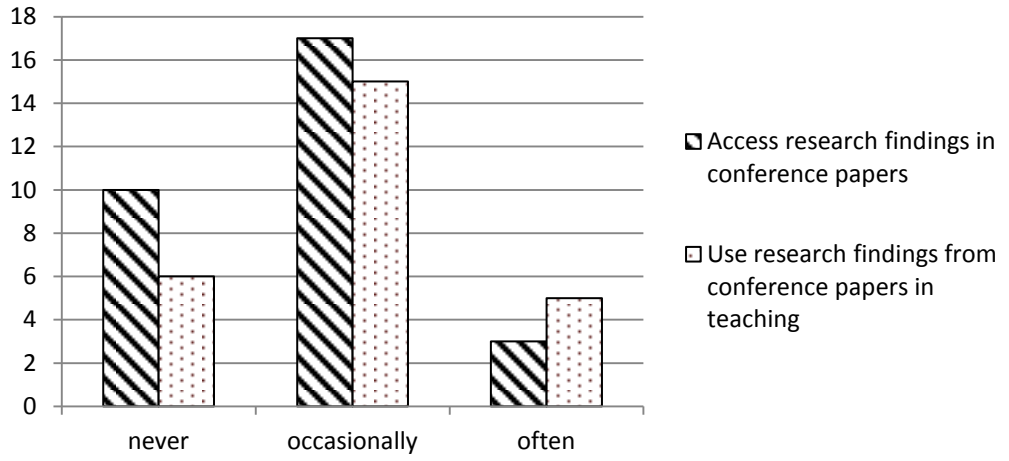
For the second question in this section, respondents were asked the same series of questions related to conference papers, i.e. do you have access to conference papers? Do you access the research findings in conference papers? Do you use the information in your teaching practice?

Of the 35 participants, 12 reported they had no access to conference papers, 22 responded yes to the first of the question series and one did not answer.

However, only 26 respondents answered all three these questions, with 16 saying they never had access to conference papers, but 20 responding yes to having access, but only three accessed and used conference papers often in their teaching. The most common answers were that

teachers occasionally access research findings and occasionally used this in their teaching, as shown in Figure 4.2. As a result from the outcomes to this question the interviews followed up with participants to explore how frequently conferences were attended and how accessible conference papers were to teachers. This will be reported in section 4.3.3.

Figure 4.2. Regularity of access to research findings in conference papers and use in teaching (n=26)



Access to Research Findings on the Internet

The third series of questions related to research findings on the internet. All 35 respondents agreed that they had access to the internet. However, only 31 answered the full set of questions. Of these, two never accessed research finding on the Internet. Eighteen occasionally accessed research findings on the Internet and 11 did so often (the highest rated often for use of research findings in teaching). Of these, a significant number (12) often used research findings in their teaching. Although the most popular answers were that teachers occasionally accessed research findings and occasionally used this in their teaching, there were almost as many respondents that accessed and used research findings often in their teaching. In the interviews, it may be useful to determine where teachers find research findings on the Internet and how easily accessible these are and how teachers use findings in their teaching pedagogy and practice.

Access to Organised Professional Development Sessions

The fourth series of questions related to organised professional development sessions. All 35 respondents indicated that they had access to professional development sessions, but only 33 gave answers for all three questions in the set. Of the 33 respondents, 20 occasionally and nine often accessed research findings from professional development sessions, but four teachers never did. Eight teachers thought that they often used the information in their teaching. This value is significant as it was the second highest value (for often using the information in teaching) in this section of questions. Elsewhere in the questionnaire, nearly seventy percent of participants agreed that they found professional development sessions useful when they were underpinned by educational research (shown in item B 3.13 in Table 4.6.). In addition, nearly 65 percent of the teachers indicated that their referrals for educational research were gained from attending courses or professional development sessions (item B 3.9 in table 4.6.). Furthermore, in the interviews some applicable examples would be sought of how professional development sessions had impacted upon teaching.

Table 4.6. Percentage of teacher agreement with statements (n=35)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Statement	**Percentile %**				
B 3.13. I find attending professional development sessions useful when they are underpinned by educational research.	0	6	24	39	30
B 3.9. Most of my referrals/suggestions for educational research are gained from attending courses/ professional development.	0	9	21	45	24

Comparing items B3.9 and B3.13 yields Figure 4.3.

Figure 4.3. Teachers' opinions about referrals or suggestions gained from professional development sessions or courses versus the usefulness of professional development sessions (n=35)

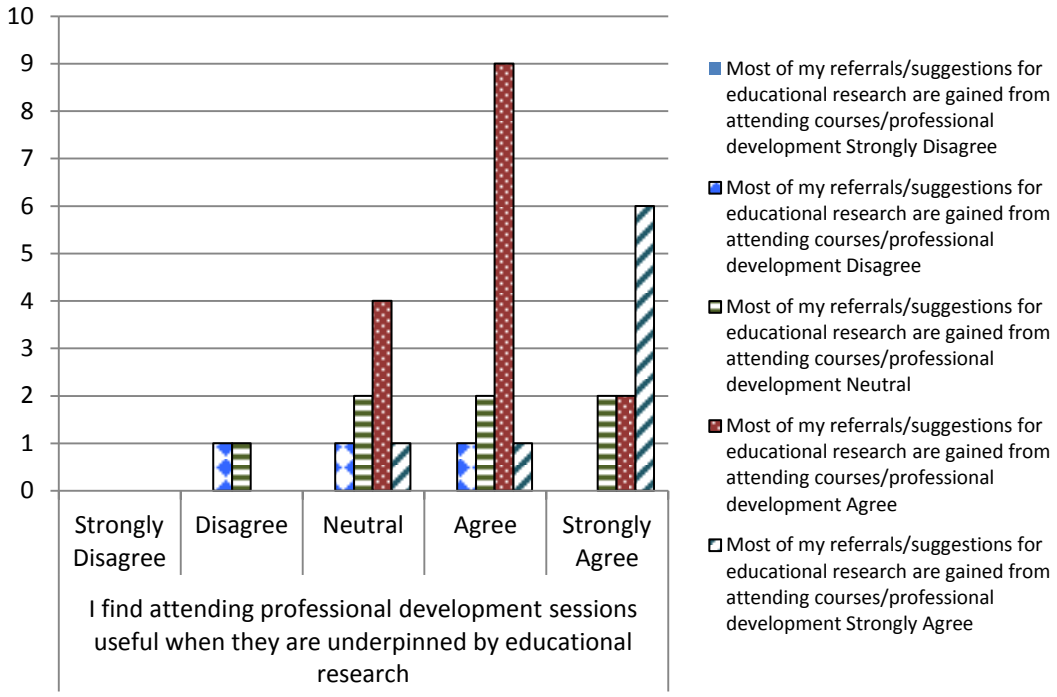


Figure 4.3. shows that even though eight teachers were neutral in their opinion about referrals or suggestions for educational research being gained from attending professional development, that four still agreed that professional development sessions were useful when underpinned by educational research. Most of the other positive instances correlated positively for agreement for both statements.

Access to School Learning Communities

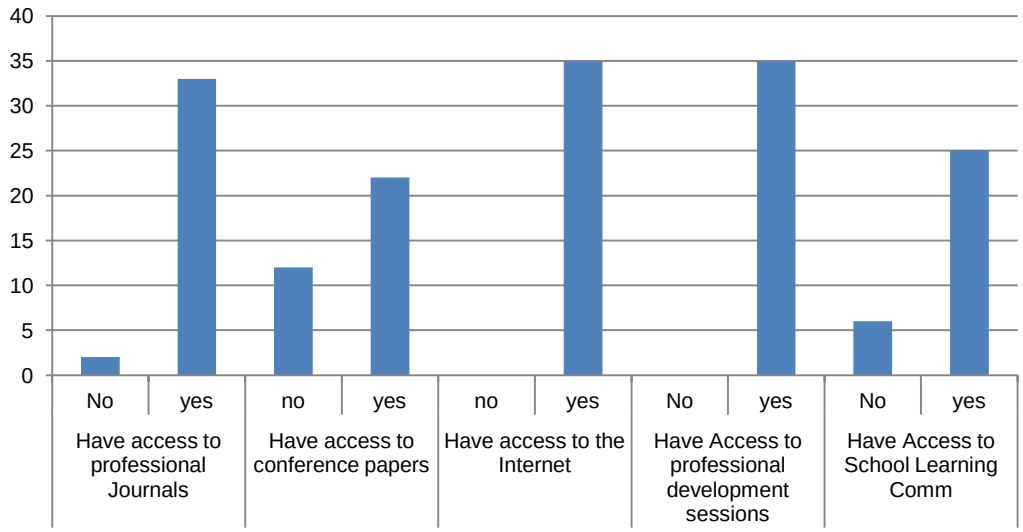
The fifth and final series of questions were about school learning communities. Six answered no, that they did not have access to school learning communities and 25 agreed that they did, whereas four did not answer the series of questions at all. Of those that did not answer, two questioned what school learning communities were. Of the 31 that answered the first question in this series, only 27 teachers answered all three questions in the set. Of the 27, only 19 indicated that they had

occasionally or often accessed research findings, but eight 8 of those often used the information in teaching.

Comparing all types of access and use of ways in which research is disseminated.

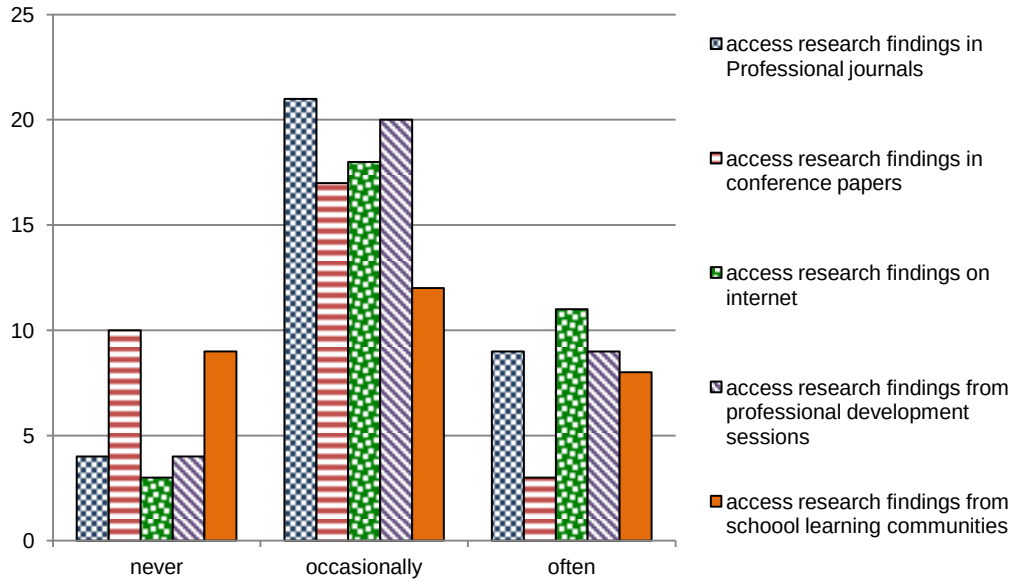
In a graphic comparison (Figure 4.4.) teachers indicated that they had accessed research findings on the internet and through professional development sessions most frequently, with all except two teachers also indicating that they had access to professional journals. Between twenty and twenty five teachers indicated that they had access to conference papers and school learning communities, however a third of the teachers (12) indicated that they did not have any access to conference papers.

Figure 4.4. Access to research findings in various sources (yes/no).



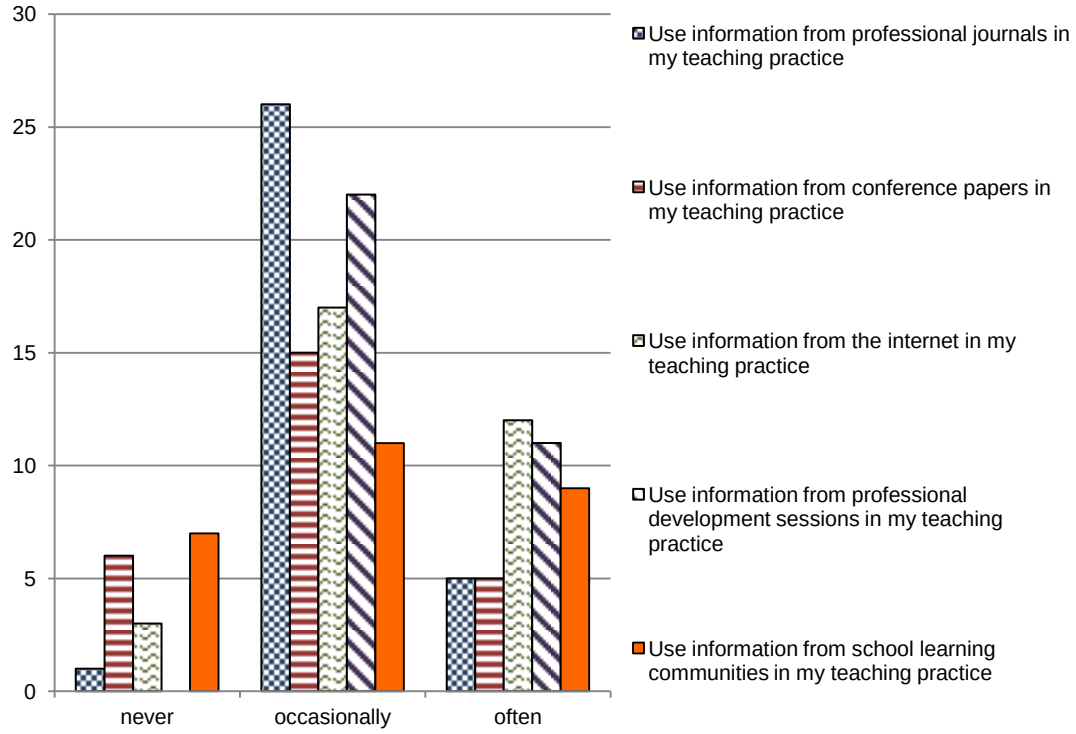
In contrasting how often the respondents accessed the research findings in each of these sources, Figure 4.5. shows that teachers accessed research findings from the internet most often and from conference papers least often.

Figure 4.5. Teachers indicated the regularity with which they accessed research findings from each of the five sources.



When comparing how often the respondents used the information accessed in their teaching (Figure 4.6.), most chose occasionally again, although comparatively, research findings were used more often in teaching when from three sources: internet, professional development and school learning communities and least often from professional journals and conference papers.

Figure 4.6. Teachers indicated the regularity with which they used research findings from each of the five sources in their teaching practice.



When looking at how teachers were accessing and using education research findings in general, which may include all the ways of accessing these as discussed extensively above, additional trends were obvious. As indicated in Table 4.7. the majority of teachers (54%) agreed that they gained valuable information from educational research, which they usually tried to translate into practice in their classroom (item B 3.5.), however, three respondents disagreed and thirteen were neutral towards this statement.

Fewer teachers (40%), agreed that much of what they read in science education research could be applied to their teaching (item B 3.8. in Table 4.7.), whereas eight teachers disagreed and a significant thirteen teachers indicated neutral. Nearly seventy percent of teachers indicated that they were supported to try new ideas in their classrooms, whereas five teachers disagreed and six were neutral to statement B 3.7.

Notably, nearly half of the respondents expressed neutral to actively seeking research findings (in response to the statement B 3.6.) and six respondents disagreed. Fourteen agreed or strongly agreed. Further questions need to be asked in the interviews to determine the reasons for these opinions.

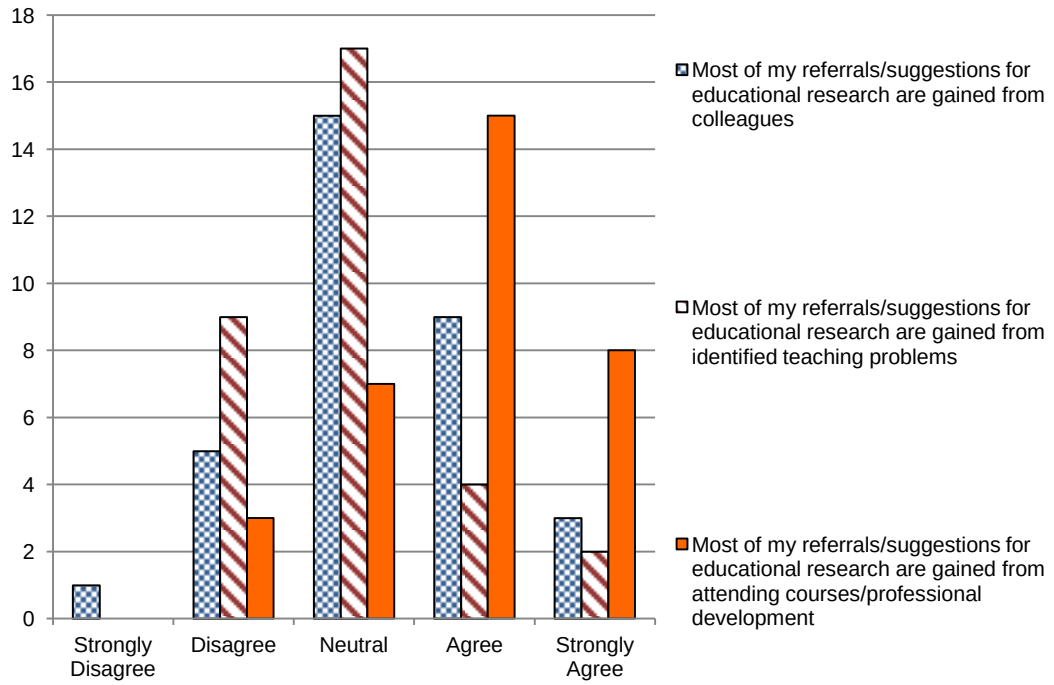
Table 4.7. Percentage of teacher agreement with further statements (n=35)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Statement	**Percentile %**				
B 3.5. I gain valuable information from educational research, which I usually try to translate into practice in my classroom.	0	9	37	46	9
B 3.6. I actively seek educational research that is relevant to my teaching.	0	17	43	34	6
B 3.7. I have opportunities to experiment with new ideas gained from educational research in my teaching practice.	0	14	17	46	23
B 3.8. Much of what I read in science education research can be applied to my teaching.	0	23	37	34	6
B 3.9. Most of my referrals/suggestions for educational research are gained from attending courses/ professional development.	0	9	21	45	24
B 3.10. Most of my referrals/suggestions for educational research are gained from colleagues in the school environment.	3	15	45	27	9
B 3.11. Most of my referrals/suggestions for educational research are guided or informed by identified teaching problems.	0	28	53	13	6

In comparing the final three statements, items B3.9, B3.10 and B3.11, the results in Figure 4.7. show that many more teachers (23 teachers in total) agreed that their suggestions/referrals for educational research were

guided by attending courses and professional development. In contrast, nearly one-third disagreed that their reading was guided by identified teaching problems, as many more teachers indicated neutral or disagreed with this last statement (B 3.11 in Table 4.7.).

Figure 4.7. Where referrals or suggestions for reading research are gained (n=35)



4.2.3. Hours spent reading educational research

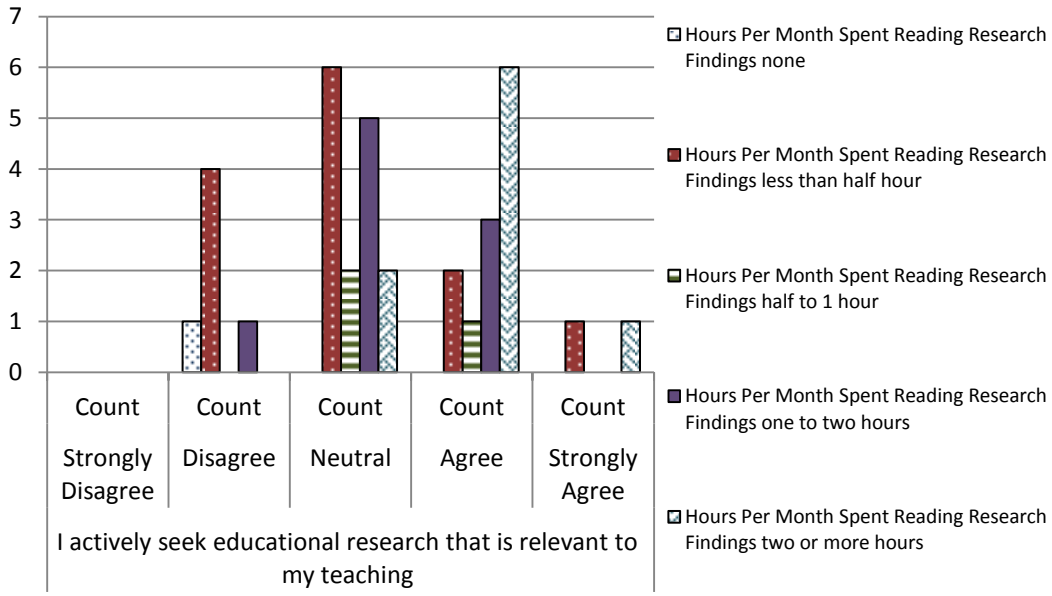
Question B2 asked the teachers 'how many hours on average, per month, would you estimate you spend on reading research findings?' The frequency Table 4.8. from the data received shows that 40 percent were reading less than half an hour of research findings per month, however more than half of the teachers indicated that they were reading more than an hour per month.

Table 4.8. Hours Per Month Spent Reading Research Findings (n=35)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	1	2.9	2.9	2.9
	less than half hour	13	37.1	37.1	40.0
	half to 1 hour	3	8.6	8.6	48.6
	one to two hours	9	25.7	25.7	74.3
	two or more hours	9	25.7	25.7	100.0
	Total	35	100.0	100.0	

When the numbers of hours teachers indicated that they read was compared with the participants' answer to item 3.6. "I actively seek educational research that is relevant to my teaching", Figure 4.8., the correlation for those that read more than two hours per month was high. However, three teachers that had indicated they read for less than half an hour per month also indicated that they actively sought research findings relevant to their teaching.

Figure 4.8. Comparing item B3.6. "I actively seek educational research that is relevant to my teaching" with the hours per month research findings read (n=35).



4.2.4. Developing pedagogy

Generally, the teachers that had responded to the questionnaires had widespread confidence in their own pedagogical content knowledge (PCK). A large majority (32 out of 35 teachers) either agreed or strongly agreed with statement B 3.1. that they considered themselves to have a deep content knowledge of the science subject(s) that they taught, and most (94%) also acknowledged that they had recognised the need to keep up to date with educational research (item B 3.4.). All thirty-five teachers were equally positive about statement B 3.2. regarding their pedagogy, and agreed that they had the instructional knowledge to assist their students to understand the science subject(s) that they taught. However, some teachers' were less certain of their knowledge regarding alternative conceptions, as a few more teachers answered neutral or negative regarding statement B 3.3.

Table 4.9. Percentage of teacher agreement with statements (n=35)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Statement	**Percentile %**				
B 3.1. I consider myself to have a deep content knowledge of the science subject(s) that I teach	0	3	6	66	26
B 3.2. I consider myself to have instructional knowledge or the 'how to teach' required to assist my students to understand the science subject(s) that I teach.	0	0	0	69	31
B 3.3. I am thoroughly aware of the alternative conceptions (misunderstandings) that students may have with some science concepts.	0	6	17	66	11
B 3.4. I recognise the need to update my subject knowledge by reading educational research.	0	0	6	66	29
B 3.12. The school at which I teach encourages me to reflect on my science teaching.	0	6	21	45	27

Although 94 percent of participants recognised the need to update their knowledge by reading educational research, this does not necessarily translate to teachers spending time reading research findings, as it is inconsistent with the time spent on reading research findings as discussed in section 4.2.2.

Two respondents disagreed with item B3.12. that 'the school at which I teach encourages me to reflect on my science teaching', although both of these teachers agreed with a previous statement (item B3.7. from Table 4.7.) about having opportunities to experiment with new ideas gained from educational research, which makes this disagreement contradictory. Seven teachers were neutral to this item B 3.12, whereas 24 participants either agreed or strongly agreed.

Section C of the questionnaire asked three open-ended questions relating to how teachers continued to develop their pedagogy, the constraints they felt they had to their lifelong learning and also possible interventions that may have been useful in overcoming constraints. Each participant's responses were entered into Microsoft Word, coded to determine themes and common themes grouped and tabulated as detailed by La Pelle (2004).

Developing in-depth content and instructional knowledge

Section C of the questionnaire indicated that the three questions to follow were a reflection on this quotation from Melville (2010):

> *Given the scale of changes that teachers face, it has been argued that teacher professional learning should not just be seen as a constant 'updating' of teachers' knowledge, skills and personal qualities; rather, teachers should be lifelong learners whose professional learning should be based on developing and enhancing in-depth content and instructional knowledge (p. 28)*

The first open question C1 'How do you develop your "in-depth content and instructional knowledge" of science teaching?' elicited a response

from 34 of the 35 teachers. Half (17) of the 34 teachers said that one way they did this was by discussion with colleagues within their school or area. Four teachers expressed that they were influenced by occurrences in the classroom and these included feedback from students or trial and error and/or observation in class.

Table 4.10. Themes identified from Question C1 (n=34).

Ways for developing "in-depth content and instructional knowledge"	
Discussion with colleagues within school/cluster/area	17
Feedback from students/trial and error/observation in class	4
Professional development	8
Chemistry teachers' conference/presentations	14
Reading journals/textbooks/internet-based journals/science magazines	18
other	5

Eight teachers specifically mentioned professional development and 14 specified their attendance at an educators' conference or presentation (of these 14 teachers, at least ten of these teachers had more than ten years experience and of these ten teachers six had more than 20 years teaching experience). More than half (18) respondents mentioned reading in their answer, in the form of reading journals or textbooks or internet-based journals or science magazines. In the final category, listed as 'other', five respondents mentioned other ways of developing their knowledge, such as a Chemistry Educators Newsletter, life experiences and viewing colleagues' lessons. This final category together with classroom feedback seemed to be the least mentioned areas to influence in-depth content and instructional knowledge.

Constraints to lifelong learning

The second open-ended question asked ‘considering your answer to the above, briefly explain any constraints to your lifelong learning in science teaching’. Of the 35 practitioners, only one did not respond to this question. Two respondents said they had no constraints. An overwhelming 28 mentioned lack of time as the primary constraint, with seven specifically mentioning that the demands of teaching were to blame.

Table 4.11. Themes identified from open-ended Question C2: ‘considering your answer to the above, briefly explain any constraints to your lifelong learning in science teaching’.

Constraints to lifelong learning in science teaching	
Lack of Time	19
Lack of Time to search for research	1
Lack of Time due to demands of the job	7
Time to keep up with the speed at which science knowledge develops	1
Lack of suitable Professional development	2
Lack of access to research journals	4
Lack of knowledge to search for research	2
Lack of support	5
Lack of support in funding	2
Lack of support in access to other teachers	2
Lack of motivating rewards	1
The lack of relevance of educational research	4
No constraints	2

Four participants wrote about a lack of access to research journals and two specifically stated that they lacked knowledge of how to search for relevant educational research. Ten practitioners referred to the lack of support they received, ranging from funding, to a shortage of access to other teachers. Four pointed out the lack of relevance of educational research to their teaching. Two expressed that there were no constraints to their lifelong learning.

Interventions that would support professional development

The final open question stated ‘considering your professional learning needs, indicate two interventions that would support you in your professional development’. As summarised in Table 4.12, out of 31 respondents (four no responses), 22 respondents specifically wrote about the provision of time, as an intervention that would support their professional learning needs. Of those 22, ten revealed their need for time, required specifically for developing ideas and/or reflecting on research and eight of these emphasised the need to meet with colleagues to collaborate or discuss research ideas. Four of these expressed the desire to study further or take a sabbatical for science research.

Table 4.12. Themes identified from Question C3: ‘considering your professional learning needs, indicate two interventions that would support you in your professional development’

Theme	
Question C3	
Interventions that would support you in your professional development	
Time	(22)
Time to access research or develop research ideas to teach, Time to reflect	10
Time to discuss research with colleagues or in workshops, collaboration between schools/ access to other teachers	8
Time/opportunity to study Sabbatical outside of teaching	4
Access to suitable Professional development	4
Easily accessible summaries of research and applicable examples. To be supplied research papers	10
Access to professional support, resources or additional funding and resources	12
Other	3

Of the 31 respondents, four pointed out that they would have liked to have more subject specific professional development. Besides time, the next

two most relevant responses were the ten that specified that they required easily accessible summaries of research and applicable examples and the 12 participants that stated that improved access to professional support, access to resources or additional funding and resources were important interventions.

4.3. Analysis of semi-structured interviews

The selection and focus of the semi-structured interview questions (see appendix B) were developed from and informed by the outcomes from the questionnaire. As discussed in chapter three, grounded theory or thematic analysis was used to analyse the semi-structured interview data. The researcher's interview notes and the memos, that became apparent as the researcher was transcribing each subsequent interview, guided the process and questioning in the interviews. The various steps of the coding process were described in detail in chapter three. A number of emerging key themes were identified, these were:

- types of research findings accessed by science teachers and why teachers are or aren't accessing findings;
- the ways in which teachers reported that research findings were informing their pedagogy; and
- the factors influencing teachers' motivation to access research findings and teachers perceived learning from research findings.

The themes are discussed in greater detail after the demographic characteristics of the nine teachers are presented.

4.3.1. Demographic characteristics of participants interviewed

Nine teachers were interviewed employing semi-structured interviews. A summary of the demographic characteristics of the nine science teachers interviewed is given in Table 4.13. Notably, one teacher is represented

from each of the ‘years of teaching experience for science teachers’ categories as illustrated in Table 4.1 at the beginning of the chapter. More female teachers completed the questionnaire, but fewer volunteered to be interviewed, hence, seven of the participants were male and two female. All of the names used are pseudonyms. Five of the nine participants were in positions of responsibility and these five also had the highest number of years of teaching experience.

The decile rating of schools in New Zealand indicates the average socio-economic rating of families of students at the school (Ministry of Education, 2011) . There are ten deciles, where decile one schools has the highest proportion of students from low socio-economic backgrounds, whereas decile ten schools have the highest proportion of students from high socio-economic backgrounds. Five of the nine teachers interviewed were teaching in schools that rated as decile ten, as shown in Table 4.13.

Table 4.13. Demographic characteristics of Science Teachers Interviewed

Science teacher pseudonym	Years of teaching experience	Gender	Background and Qualifications	Type of school	Position(s) and significant other
"Clive"	20	M	BSc in 1991; Diploma in teaching 1992, Master in Education in 2010. Previously head of science department (for 10 years)	State all boys Decile 10 school	Currently 2nd year as deputy principal; chemistry teacher
"Peter"	2	M	BSc chemistry 2006, diploma in teaching 2006	Integrated all boys school, decile 10	Chemistry teacher; 1st year at new school.
"Elaine"	2	F	PhD in biology then worked as a scientist for 7 years, then completed a Graduate diploma in teaching 2 years ago.	State all boys school, decile 6 in more rural area	The only chemistry teacher at the school
"Fred"	6	M	PhD in geology in 1995. Completed a teaching diploma 6 years ago.	Decile 10 single sex state school	Chemistry teacher
"Sue"	2	F	BSc in 2004 and MSc 2008 then a teaching diploma 2009	Decile 10 single sex integrated school	Chemistry teacher; youngest teacher at school (by far).
"Adam"	13	M	Completed a BSc, and teaching diploma (both done in five years) by 1993	Decile 8 co-ed state school	Head of science (15 staff) and head of chemistry; chemistry teacher
"Neil"	29	M	PhD completed in 2010 (focus was on learning environments). MSc chemistry 1993	State school decile 7 co-ed.	Dean, head of science; head of chemistry; chemistry teacher; lecturer at university.
"David"	13	M	BSc 1994 and diploma in teaching 1997	State, decile 2 school in a provincial town	Chemistry teacher and 2nd year in educational leadership as 'director of teaching & learning'.
"Joel"	32	M	BSc and MSc in 1970's, diploma in teaching in 1982	Independent single sex decile 10	Head of chemistry; chemistry teacher

4.3.2. Ways in which research findings are accessed and used

The nine teachers interviewed indicated that the three primary sources for obtaining research findings were from

- professional development sessions (including attending conferences),

- reading professional journals and
- from searches on the internet.

All nine teachers interviewed were present at a chemistry teachers' conference, but the usefulness and applicability of the information received at the conference varied from one individual teacher to the next, with two teachers admitting that they were unable to identify one thing they had applied from the conference in the months following. Adam (pseudonym) admitted that he "did find [the conference] useful and interesting [but he would] probably struggle to name specific stuff that [he had] applied in [his teaching] since going to it" (p. 4). However, two other teachers gave examples of information that they had applied in their practice since the conference a few months earlier.

Although the internet was cited as a source of research findings for teachers, no examples of this were given in the interviews and the suspected reasons for this will be discussed in the section following.

Teachers were asked in the interviews about the types of professional journals they had access to and which ones they had found useful to apply to their teaching. The majority of the teachers had access to science education research journals and had used these to some extent to inform their teaching. However fewer participants mentioned access to educational research journals as summarised in Table 4.14. In effect, once duplications were removed, six of the nine teachers were accessing useful science education research journals and four of the teachers interviewed were accessing general educational research journals.

Table 4.14. Titles of Journals accessed by science teachers interviewed (n=9)

Number of Teachers n = 9	Type of educational journal	Journals accessed and found to be useful	Teacher pseudonym
6	Science Education Research journals	Chemistry Education NZ	Clive, Peter, Sue, Adam, Neil, Joel
3		NZ Science Teacher	Clive, Peter, Sue
2	General Educational Research journals	Education Gazette	Clive, Peter
2		Set: research information for teachers	Elaine, David
1		New Zealand Journal of Education	David

In addition to individual journal titles, three teachers (Adam, Neil and Joel) also mentioned that their school subscribed to receive a package consisting of six informative chemistry education journals, including Chemistry Education New Zealand, and similar science education journals from four other countries, distributed by the Royal Society of Chemistry in the UK.

The amount of time teachers spent reading and searching varied greatly. For example, Peter would “flip through” (p. 2) the Education Gazette and preferred to read the shorter notes, reviews and commentaries. When asked what professional journals she was accessing, Sue replied “it is really difficult to access them, because you sort of look at what comes through the staffroom at school and so I haven’t really looked at anything in the last two years...” (p. 3).

4.3.3. Factors that teachers reported influenced the ways in which accessing research findings informed teachers' pedagogy

Participants were asked in the interview about the ways in which they perceived research findings had informed their teaching. From the semi-structured interviews several factors were identified that teachers perceived influenced the ways in which accessing research findings informed pedagogy and practice to enable teachers to develop as reflective practitioners. These were:

- collegiality and the school learning community,
- the teacher focus,
- the type of seeker,
- opportunities for teacher learning through professional development,
- postgraduate study
- constraints to access

Collegiality and School Learning Communities

All except two of the teachers interviewed articulated that some of their knowledge about various research findings occurred through contact with colleagues, either in an informal discussion between colleagues that were more close-knit or in a more formal setting. This was either in the sense of sharing findings upon return from a conference with colleagues at a meeting, or co-construction of ideas by a group of teachers to effect change in the case of professional learning groups. David explained that he was able to learn from some colleagues more than others, he explained it as a "…dialogue, it's that professional discussion that you can get going if you get going with the right people" (p. 6). These professional learning communities were termed 'school learning communities' in the questionnaire. Other types of sharing of research findings between teachers occurred online through a Virtual Learning Network or a Twitter community for science educators that frequently learned from and

supported one other. However, none of the participants gave explicit examples of research findings gained in this way that had informed their practice.

However, participants frequently associated professional learning with what was occurring in more formal organised professional development sessions and courses, hence this warrants further discussion, in a subsequent section.

Teacher Focus

Each participant was categorised by the researcher to have a primary focus, largely dependent on four variables; namely the amount of time spent on seeking research findings, attending conferences and general orientation to seeking out research findings and also in applying research findings in practice. Three primary foci have been identified, namely;

- a focus on science education,
- on general educational, and
- on leadership/management.

Some teachers also displayed a relatively strong additional focus, this was termed a secondary focus. Table 4.15. shows a summary of these foci for each teacher interviewed.

Table 4.15. Table of foci (as identified by researcher) of science teachers interviewed (n=9)

Focus	Primary focus Teacher pseudonym	Secondary focus Teacher pseudonym
General educational	Clive, Neil, David	Joel, Elaine
Science education	Peter, Elaine, Fred, Sue, Adam, Joel	Neil
Leadership / management		Clive, David

In general, each participant had either a primary focus of science education or a generic educational focus. In the former case the teacher indicated they had read and possibly sought more of mostly science education research and in the latter case, those teachers suggested that they had read more general educational research and may have sought more of the same, depending on how much they sought.

In some cases the distinction regarding a particular focus was not clear. For example, in the semi structured interview, the researcher asked Elaine (previously a research scientist) several times about her access to research findings, her first reactions were around scientific and science research, and she admitted that she accessed “more … natures and science … whereas when I was a scientist it was more specific … microbiology or something” (p. 2) and her examples of application were related to this. However, later in the interview Elaine was talking about professional development on behaviour management reviewing that she possibly read more educational research than she initially thought “probably … my reading is more general teaching as opposed to straight teaching of science” (p. 3). From the whole semi-structured interview exchange it seemed that science education was her primary focus as she gave more examples related to science education.

Other participants’ primary focus was clearly evident in their own thinking. Clive explained that years before he had lacked in some areas of knowledge, he felt “pretty fine with [his] subject knowledge but not around educational theory” (p. 1) hence he recognised that he no longer “read much science stuff anymore [but he tended] to read educational things” (p. 6) that aligned with his thinking and as he put it “things that get me going” (p. 6).

Another example was Adam who referred during the interview to primarily having a science focus, specifically when talking about the professional journals that he had access to…

> *… we subscribe to the Royal Society Schools package which is 'Education in Chemistry' plus various others as well, and we get Chemistry Education New Zealand as part of that, plus we get it directly. Um, some of it is just chemistry, um, examples of chemistry that have been introduced, sort of real life chemistry into the classroom or sort of links to it. Um, and to be honest, there is probably more of that than actual, um, research in to chemistry and science teaching. There are some articles that are based around that, but quite a lot of it more stuff, if you like, that you can use in the classroom, rather than specifically about, um, you know, education research (p. 3).*

Sue felt that as a scientist previously, her scientific knowledge was useful and as a second year teacher, science education was her focus at the time of the interview, however she felt that her general educational and pedagogical knowledge required more updating despite having done a teaching diploma the year before entering teaching. Sue indicated that she wanted to focus on a Masters in Education in the near future, giving reasons:

> *It's because I still feel like my education into education is not complete. I've still got some holes in my own understandings …of how students learn, different environments and how I can make an optimum learning environment for them… I don't have all the tools in my toolbox that I want yet (p. 6).*

Conversely, David in a leadership position at his school, had various foci, but education in general was a strong theme throughout the interview with him. He spoke about a variety of important educational strategies that he had been able to implement successfully in the classroom, ranging from clear learning intentions and inquiry learning to making learning "more student-centred, instead of me standing in front of the class teaching" (p. 6). David further explained that he attended:

> *…a lot of professional learning, more than is [provided for by the school], I pay for all [the additional conferences] myself, because I know that if I don't go to it, I don't get the ideas and I don't stay ahead (p. 6).*

David also expressed that he felt that a primary focus on educational leadership could jeopardise his teaching pedagogies if he did not actively seek educational research and seek to keep his teaching strategies in updated.

Type of 'seeker'

Teachers were asked about the types of research findings that they had searched for, and then probed for further details about the frequency of searching, quantity of reading and asked to identify how they thought this had changed their teaching practice. This 'seeking' aspect affected the ways in which teachers accessed research findings and how they perceived it had informed their teaching. After analysing interviews, the researcher classified four of the nine teachers interviewed as 'active seekers' of research findings (as shown in Table 4.16.), two teachers were considered 'erratic seekers' that infrequently sought research findings. Three teachers displayed characteristics of 'passive seekers' as they never went out to seek research findings, but occasionally read journals that they were given to them or that they happened to find in the staffroom at school.

Table 4.16. Table of types of 'seeker' (as identified by researcher) of science teachers interviewed (n=9)

Type of 'seeker'	Teacher pseudonym
Active seekers	Clive, Neil, David and Joel
Erratic seekers	Elaine and Sue
Passive seekers	Fred, Adam and Peter

All four participants that were classified as ‘active seekers’ were experienced teachers with between thirteen and thirty-two years of experience. All four were male teachers and were also in leadership positions at their school. One teacher (David) sought research findings primarily by attending every possible national conference in education and in science education. However, he admitted that he did not always follow up with reading the papers from these conferences although he frequently sought further information on research he found had interested him. One teacher (Joel) attended the most conferences nationally and internationally of all the teachers interviewed, followed up on conference papers, and spent a significant amount time seeking and reading research findings beyond what was received at conferences. Two teachers (Neil and Clive) did attend some conferences, but moreover actively sought educational research that aligned with their thinking and spent significant amounts of time searching for additional findings and reading through new research findings. For example, one of these teachers (Clive) conveyed the usefulness and applicability of published works by Russell Bishop of the Te Kotahitanga project that seeks to improve the educational achievement of Maori students in mainstream school, the Best Iterative Synthesis (BES), and had accessed research carried out by the New Zealand Council for Educational Research (NZCER) and the New Zealand Qualifications Authority (NZQA), and the Te Kete Ipurangi (TKI) website and further links from those websites. He demonstrated how he had accessed useful research findings online and was also knowledgeable about where to go to find these, clearly articulating how some findings were applied and how these had changed his teaching.

Elaine and Sue, both in their second year of teaching, were categorised as ‘erratic seekers’. Elaine had accessed some educational research journals online, however could not give explicit examples or elaborate, but rather explained how limited journal access was. Sue read the snippets from newsletters like the Royal Society of Chemistry (RSC) and from the Teachers’ Council newsletter and occasionally followed the web links provided. However Sue explained that because she had no access to

conference papers or the university library, she was unable to follow up on journals or other papers. Furthermore, Sue indicated that her reading was irregular:

> *I will read up on something if I am interested in it, so it will be sometimes during non-contact [time] if I have nothing else to do, or if I'm procrastinating …if I am being honest. I will quite often see snippets in things like the PTA or the Royal Society Newsletter that comes out for science teachers [and] sometimes you just ignore them, but other times I've got something I will look at reading through it (p. 6).*

Of the 'passive seekers', two teachers (Fred and Peter) expressed that they did not actively seek research findings at all. Adam initially said that he occasionally sought research findings, but after further questioning it was evident that he had been searching for mostly resources rather than research findings.

Although teachers may recognise the difference between research findings and searching for resources for teaching, many of the teachers interviewed tended to clump research findings with practical teaching resources and spoke about them interchangeably. Often in the interviews when teachers were asked about accessing educational research findings, their answers would revert back to the search for more practical resources. For at least six of the teachers interviewed, resources were more often the focus of their search for information, whether this was in the form of topic information, videos, worksheets, media presentations or ways of presenting difficult topics. This was well illustrated by Elaine when asked what she was finding most useful from professional journals she replied:

> *…those shorter notes, you don't want to read a whole [paper] anymore for a school base. It's more those reviews or commentary as opposed to the straight nitty gritty scientific papers… not so much your straight professional journals, but more like … Cosmos,*

> *science magazines, some of those ones… because it is a bit more accessible for [the students], they can read that as well (p. 2).*

In the interview with Neil we were discussing what he was accessing and using from professional journals and he said:

> *It's what I can find at the time and that varies from a good journal article to a site that some teacher has put together that is useful for, for me because of what I am doing at the time. Where someone has got experimental method or a good chemistry demonstration, something I can use quickly. So it's useful in that sense that you can find something quickly that will give you an idea and gives you a good starting point. I often use it either as, like a starter for my teaching or a starter for me to figure out what I am going to do with my teaching (p. 2).*

Four teachers (Elaine, Fred, Peter and Sue) indicated that they were searching more for resources that contained science content or magazines that were useful for the students to be able to understand. Three of these four teachers were in their second year of teaching and one in his sixth year of teaching. Fred agreed that in instances that he was looking for solutions to identified teaching problems or poor performance of learners on a particular topic, that he would search "for different ways of presenting information" (p. 2) and often this resulted in finding different activities, although he admitted that he was likely "looking in the wrong places for the research findings of science education researchers" (p. 2), thus he tended to find and use more resources or activities as opposed to educational research to apply to his teaching.

The search for resources as opposed to research findings was particularly evident when interviewees were asked for examples of research findings that had changed their teaching practice. Elaine replied:

> *I use the Science Hub quite a bit, its got links to scientists, videos on certain topics. I have shown the boys. It's a starting point and*

> *that programme … Ever Wondered. I have used that a few times (p. 2).*

Another example was Peter, who occasionally stumbled on some good examples of chemistry experiments from the New Zealand Science Teacher journal, in his words:

> *I found a couple of interesting activities or explored greater detail of a particular science topic that maybe we happened to be doing at the time, so it's useful to bring that into the classroom and explain things. … other than that I probably wouldn't have bothered or thought of otherwise (p. 2).*

When he was asked if he was able to determine if he was accessing any educational research, he responded that he would "flip through [the Education Gazette] from time to time to see what's going on" (p. 2). With even further questioning to determine the extent to which educational research was informing his teaching, Peter admitted that it is "probably not in any huge amount but if I read something like that then I will try and incorporate it" (p. 2).

Seven of the teachers interviewed were able to give at least one example of research findings that had informed or changed their teaching practice. In some cases the question had to be asked several times throughout the interview in slightly different ways to elicit a suitable response, as some answers were initially given in terms of access to resources that been applied in the classroom, as discussed previously. However, those that actively sought research findings expressed more explicit and varied examples of research findings as oppose to resources that had informed their teaching and were usually able to give these immediately.

Opportunities for teacher learning through professional development

Both the quality and quantity of professional development available at different schools was wide-ranging, as reported by teachers in the interviews. As a result the amount of research findings made accessible

through professional development also varied greatly and thus the way in which these findings informed teaching. At some schools, professional development seemed to receive very little attention and the school ethos was not focussed on the professional development of their teachers. Typically at these types of schools, teachers indicated they attended some form of external professional development once per year or alternative year, for example the chemistry teachers' conference, but little or no internal professional development sessions were offered. A summary of the average of professional development received by each teacher was categorised in Table 4.17.

Table 4.17. Average quantity of professional development provided for science teachers interviewed (n=9).

Quantity of Professional Development (averages)		Frequency n=9	Teacher pseudonym
Internally	Externally		
(provided within the school setting, either by another teacher or outside expert coming to the school)	(e.g. attending a conference).		
None	Usually one conference per year	3	Fred, Peter, David
Once per week (between 1 to 2 hours) or equivalent	Usually one conference per year	5	Clive, Sue, Neil, Adam, Elaine
2 hours or more per week	Average several national conferences per year and one international conference every second year	1	Joel

The deviation of types of professional development that were provided internally from one school to the next is significant. For example, Sue explained that in her school there was a strong focus is implementing an e-portfolio system and the one hour per week was been for this only, for the best part of the previous year. However, this teacher reported that no room had been made for up-skilling individual teachers' generic

educational research (as an individual choice for the teacher's personalised learning). At the opposite extreme, teachers explained that in some cases school leadership required too much professional development. An example of this was a school where a focus on developing teachers' pedagogy had developed and reflected in the words of David:

> *There is a lot of professional development happening in the school…there is probably a little too much, because a lot of the staff can't handle [it] because there [is also] a requirement that teachers are investigating their own practice (p. 3).*

According to Joel, the school where he taught showed a balanced approach for internal professional development allowed sufficient time for coverage of three main areas; namely general educational research, curriculum subject based development and also individual choice (for example ICT or a specific learning pedagogy). The professional development, held once per week for 90 minutes and was divided throughout the year to cover each of the three areas approximately equally.

Some schools were clearly still struggling to provide personalised and balanced amounts of professional development for the staff, perhaps reflecting the school's ethos, as shown in the words of Peter:

> *There certainly doesn't seem to be much of that [professional development] here [at this school]….,but we do [have a] specialist classroom teacher and [he is] also in charge of professional development stuff. He is pushing really hard for everybody to be involved in self-appraisal … so we are encouraged to do that but it is not really backed up with any sort of time. He has made himself available [but] it is pushed by him rather than the whole school backing, I think (p. 4).*

As was indicated in Peter's responses in the interview, little personalised professional development was taking place where he was as a

provisionally registered teacher in his second year of teaching. When asked whether or not professional development was offered, his response indicated that he had only attend one external event, the chemistry teachers' conference in the middle of the year. During the previous year he had attended two short courses relating to classroom management, however felt that he had not yet sufficiently applied the information gained from the courses to his teaching practice. He felt he could justify the reason for not having done more courses during the current year because:

> *I have not really felt the need so much for that this year. Because I don't really feel like I have digested the information that I collected last year properly. I remember going to one of those PD [professional development] days and actually purchasing one of the books that she [the presenter] was selling, but I haven't even, … had time to really read that, let alone sort of apply too much of that to the classroom" (p. 4).*

For Clive, a deputy head, professional learning was something he identified both as crucial for himself and for the needs all the teachers at his school. He administered and managed the professional development budget and also frequently disseminated some research findings in sessions to other staff. He similarly encouraged colleagues to take the lead in presenting and becoming knowledgeable in an area of educational research, thus individual teachers were able to present professional development sessions. He articulated that at his school both the individual teacher's professional development and the school's focus were valued, in his words:

> *Staff can apply to access funding to support them going to various courses [as it] benefits them going to various courses and things like that but we want to always align it with the strategic vision of the school or the staff's appraisal goal (p. 2)*

Clive ran professional development sessions for heads of department twice a term and the whole school had a two-hour professional

development session every week. A great deal of planning and personalised development was emphasised at Clive's school. The fact that two hours per week were set aside for professional development alone expressed the schools' ethos and commitment to continual professional learning.

For Joel, a highly reflective practitioner, the changes in his teaching could be attributed to his interest in advancing chemistry education; by attending every possible conference in science and specifically chemistry education, by presenting numerous professional development sessions and being involved with teacher organisations, learning initiatives and writing achievement standards. Joel verbalised that he was an avid reader and spent significant amounts of time searching on the Internet for more information than he received from conferences and reading professional journals. The changes he identified in the interview spanned over a number of decades and included the three-dimensional model view of chemistry "…namely the macro, what kids actually see, the molecular level and then the representational level" (p. 1). Joel explained how this changed his teaching to make students aware of the view they were working in and he also included more molecular animations in teaching. Later, a fourth dimension of chemistry "… the impact of chemistry in society and the impact on people, the environment and the world and particularly the people involved" (p. 2) lead Joel to include more historical anecdotes to contextualise his chemistry teaching. Further than this, Joel explained in detail at least another five ways in which research findings had impacted his teaching practice. Joel had identified the sources for most of these changes from initially attending conferences but also from reading up extensively following this initial exposure to various applicable research findings.

Three teachers identified how research findings from professional development sessions had informed their teaching. Elaine explained how a professional development course in classroom management had changed her teaching style. Adam expressed how research findings had

impacted his lessons, in that they were more learner centred and he gave clearer learning intentions in the lessons, although he could not identify a specific source associated with his professional learning related to these ideas. Peter illustrated how a professional development course attended in the previous year at his previous school, in behaviour management had impacted on the way he managed the students in his classes. However, when asked to what extent educational research informs his teaching, Peter admitted "I don't really know, probably not in any huge amount, necessarily, in terms of like research, but I am certainly … I am always trying to look for new ideas and so if I read something like that then I will try and incorporate it" (p. 3).

Postgraduate study

Clive, another highly to reflective practitioner, was able to identify two changes in his teaching practice, the first being that he had shifted his view of teaching from a chemistry teacher to a teacher of chemistry, explaining how he had come to focus more on the students he taught, as he said "we teach students, not subjects" (p. 4). The second change he identified was as a direct result of the study he completed for his Masters' thesis, in applying formative assessment in the classroom. He says about formative assessment:

> *I think that massively changed my practise in terms of the quality of feedback I give students, [and] the way I'd structure learning in the classroom, the use of learning objectives and assessment criteria. Rather than just a score, like we all use to do and…it really had positive effects on students learning as well (p. 4).*

Neil completed for his doctorate in learning environments the year prior to the interview and it seemed to have had a similar dramatic impact on his teaching. He reviewed this in the interview:

> *…more and more I am finding that the two things that are the most important for kids learning are relationship with the teacher and*

> *their own self-efficacy, so making sure that you are encouraging and building up their self-efficacy, that's really, really important…certainly that's what my research showed and a lot of the reading I did when I was doing [my doctoral thesis], demonstrated that as well (p. 4).*

Although both Clive and Neil above had identified the changes made to their practice as a result of postgraduate studies, a thesis study did not need to be the reason for changes applied in the classroom, but engaging with research was the reason for change in all cases.

Constraints to access of published material

Following are the constraints teachers have indicated they had with regards to accessing published material and research findings. These have broadly been divided into information isolation and the demands of day-to-day teaching.

1. *Information isolation*

The information isolation identified from interview themes was categorised into five areas, namely access isolation, isolation due to location and mental isolation, isolation within schools, volume of research findings available and course work isolation, as summarised in Table 4.18 with the number of teachers that had verbalised these concerns.

Table 4.18. Categories of information isolation as identified by researcher of science teachers interviewed (N=9)

Category of information isolation	Teacher pseudonym	Frequency n=9
Access isolation	Elaine, Fred, Neil, Sue, Adam	5
Location and/or mental isolation	Joel, Neil, Sue, Adam	4
Within schools	Fred, Peter, Joel, Sue	4
Volume of research findings	Peter, Adam, Elaine, Fred	4
Teaching diploma Course work	Peter, Fred	2

Five of the teachers interviewed expressed that they felt isolated due to not being able to access research findings information adequately. Elaine expressed her preference to search for original journal articles saying "go back and read the original because that's how, sort of, I was trained up to do it" She explained that "… I suppose it's harder now not having straight access to university as much as I use to" (p. 2). Elaine alluded to the fact that copyright exists for much of published work restricting the ways that individuals can access published material. She explained that she found opportunities for using professional journals restricted, explaining that she did not have access to the relevant teacher and professional journals. Elaine also said she felt "quite isolated" (p. 6) as she was unable to attend presentations at the University and gain more information, in comparison to living and teaching in a University town where she had previously studied.

This idea was echoed by Fred as he explained that since his formal study six years earlier he felt that "being in a school a bit more isolated from that sort of information [educational research]" (p. 1) meant that he had not been able to access the "research findings produced by researchers at the universities" (p. 2) and admitted that "research findings produced by researchers at the universities, I don't get to see those basically" (p. 2). When asked what data bases the school had access to Fred said that he did not know "…realistically it's probably a wee bit of me getting off my backside and actively searching for it and uh, finding out a wee bit more about what access our library probably already has for us to look for that material" (p. 7)

In the semi-structured interview with Neil, he was talking about accessing information and when asked if he used Google Scholar to access it, he replied "I used that a lot when I did my research. I use it a bit for teaching, but I have got less access now because some of those papers are, um , you have to pay for" (p. 2). Neil expressed information isolation in terms of affordability as "a lot of … professional journals require someone to pay, which makes it really hard for the working teacher to access it" (p. 2).

Sue spoke about not being able to access relevant information because of "having to pay for it..." (p. 8) and saying that she did not access the same type of research as "when I was a student at the College of Education because then I had access to the university library whereas here I don't" (p. 2) . Adam indicated that he personally paid for a subscription to Set (research information for teachers journal) in order to have access to the information in it and explained that he paid out of his own finances to attend additional educational conferences he felt he needed to attend in order to keep abreast of educational research.

The mental isolation was due to teachers expressing the view that research findings were aimed primarily at the research community, laborious to wade through and highly inapplicable to their work in the classroom:

> *...because it is disjointed, it does not work; it doesn't translate naturally into a classroom, into my classroom practice (Neil, p. 3).*
>
> *... where does that research come from and where does it go? It seems to all be in academic land rather than get down to the people who are working (Sue, p. 8).*
>
> *... a lot of the ... papers that are written are probably written more for other academics rather than for a teacher audience, so some of the stuff you read you have to pile through a lot of stuff, the methodology and so on to actually get to the nitty gritty in terms of how it could be applied in the classroom (Adam, p. 3).*
>
> *… but much of it is not useful for the everyday teacher, who ... [does not] need to know the theoretical background as to why, I just need to know what I can do about it (Joel, p. 9).*

The second form of information isolation was identified within the schools. Four teachers specifically mentioned that the science education and educational research journals, such as Set: research information for teachers and NZ Science Teacher that were delivered to the school were circulated "spasmodically" (Fred, p. 1) although they recognised that often

the school or head of department had received the journals. Often the journals were looked at if "it happens to [be] in the staffroom" (Peter, p. 7). To eliminate this problem in one school, one particularly proactive head of chemistry mentioned that he always read the incoming journals first and placed "sticky notes" (Joel, p. 7) alongside articles or links that were of interest for his colleagues or that he could then discuss with them. At least three interviewees considered that to overcome this problem, research findings should be accessible by having either access to a website that held this type of information or an email type format that was sent to individual teachers' email inbox, enabling direct access to information.

A third aspect of information isolation may be due to the sheer volume of educational research available and the daunting task of searching, not knowing where to look and teachers fearing that they were not able to do this on their own. Teachers expressed that they felt excluded from the world of researchers and research findings that they thought were aimed at academia with little relevance to them, for instance Sue indicated that she felt frustrated in not always "knowing where to find research…[or] being able to access it" (p. 8).

Five teachers expressed that research findings should be shared using a common forum or hub, thus access made simpler to teachers:

> *I feel like I am surrounded by some [research], it's just not knowing what, where is a good place to start really ... maybe a hub of, pointing you to all the stuff, ... some forum that someone can share something useful that they have read somewhere. So I think the challenge is the stuff is there, but there is no clear way to share it (Peter, p. 3-4).*
>
> *If there was ... a magazine or even just a website that one could go to on a regular basis with summarised research findings (Fred, p. 4).*
>
> *I think... if I knew where to go, specifically for New Zealand based [research findings] but not necessarily with the full-blown version,*

> *but something that is slimmed down … and how it would be useful in the classroom (Adam, p. 6).*
>
> *If you don't have to look for [educational research] so hard [because] it's a time thing, so it needs to find you as opposed to you having to find it (Elaine, p. 8).*

The fourth type of information isolation identified may seem contradictory at first glance, but may pose the biggest obstacle to the teachers that identified this as problematic. Two of the teachers interviewed, expressed that although they had received a significant amount of education research findings within their respective courses (of their post graduate teaching diploma), that the work covered seemed completely isolated from their teaching practice at the time of their studies. They had received the readings during their teacher training, been exposed to much education research in their teaching diploma courses, yet they doubted they had been able to apply the theory subsequently, to their teaching practice once they were in the classroom. One teacher expressed that he had the desire to revisit the readings he had received in the graduate diploma programme, as he felt these would be a rich source of information, but towards the end of two years of teaching, he still had not found the time to do so.

2. *Teaching Day-to-Day*

Secondary school science teaching was considered by nearly all of the teachers interviewed as a considerably demanding job; identifying difficult, tiring and time-consuming tasks that had to be completed. Most teachers identified the demands of teaching as competing; some considered the demands as excessive or even increasing. Given the more immediate day-to-day demands, teachers found little, if any, time available to search for research findings. Teachers who reported reading research articles

indicated that where possible, they read in their spare time and that no time was made available at school specifically for reading:

> *One actually has to remember [that to] do the job of actually teaching … one has to balance that against the time available to go searching for those [research findings] (Fred, p. 4).*

> *I probably haven't done so much [reading of research findings] lately, [because] teaching [is] all consuming (Elaine, p. 4).*

> *I don't read at school particularly, I just read in the evenings at home and I quite enjoy that, ... I find it is part of my leisure activity to be honest (Clive, p. 6).*

Peter expressed that time was a real issue for him as a second year teacher. He felt that all the other demands of teaching left little time and energy for reading research:

> *I guess you … need to be forced to set aside time to do it, reading an hour or something like that a week, where you are just going to sit down and read (p. 4).*

Neil, a very experienced teacher who had completed his PhD the previous year conveyed his frustration about the lack of time available to him to apply research findings to practice in his teaching. He continued to say that research findings:

> *…should be focussed on what happens in a classroom, rather than focussed on what happens in academia [as] research findings take a lot of interpretation before you can use them in the classroom [thus] there is a big disjoint between what's going on in research and what's happening in real classrooms [so] someone needs to bridge that gap [but] teachers spend all their time teaching, they haven't really got time to figure out how to bridge the gap (p. 3).*

The constraints relating to information isolation and the pressure of teaching day-to-day all resulted in less access and use of research findings by these teachers.

4.3.4. Factors influencing teachers' motivation to access research findings

In this section a number of factors that were identified from the interviews with nine teachers regarding their motivation to access research findings are discussed. These included drivers that influenced teachers' motivation to access research findings; factors that enabled or could enable teachers to search for research findings and how the degree of self-motivation influences how teachers access findings.

Drivers

Interview answers identified some common drivers that teachers gave for wanting to seek research findings and also the occasions on which they did act to do so. One common driver, expressed by five of the nine teachers interviewed, for seeking research findings, was the acknowledgement that education is continually evolving and therefore they had a desire to stay informed as lifelong learners.

Neil revealed how strongly he felt about actively remaining informed about the evolving nature of education "..if you think you have learnt everything in this job, it's time to stop" (p. 4). Other teachers like Elaine were more concerned with the changes occurring in science in the context of how these relate to the scientific method and the work she was teaching, as she explained that science is "...dynamic [so] the research is good in ...keeping you up to date, so that you know [that] the information you are giving is correct" (p. 7). Other teachers expressed the need to remain abreast because they had recognised that they had some shortcomings in their knowledge in a specific area (either educational or science subject specific) resulting in a desire to gain information that was topical, current

and relevant but the context varied for different teachers. Clive reflected on his own lack of educational theory knowledge that had motivated him to complete a Masters degree in Education a year prior to the interview.

A similarly common driver given by teachers was the recognition of student difficulty or underperformance in specific or more difficult course content and consequently searching for ways to improve teacher presentation and thus impact on student learning, expressed by Adam as "improved education experiences for students" (p. 4). Elaine wanted her weaker students to be "literate about science" (p. 6) and thus sought ideas that would be practical and applicable for them. Joel explained how he desired to find ways to adjust the delivery of concepts as the students encountered difficulties in their learning.

Enablers

Enablers were identified for individuals actively seeking research findings and for those that were not actively seeking. Some of the enablers were verbalised as supportive interventions or how teachers felt their access to research findings could be enabled in the future. These were broadly discussed under categories of 'environment and responsibilities' and under a second section relating to assisting teacher learning.

1. *Environment and responsibilities*

One key enabler for seeking research findings was the school environment or ethos. When the school management team was vanguard in educational research applications and focussed on developing staff, encouraging teachers to develop in the professional sense, this was reflected in the interview. What was unclear was whether these types of schools encouraged 'actively seeking' teachers and management or whether the leader/teacher pushed for forward-thinking teachers in their respective schools. However what was more obvious was that those

teachers identified earlier as ‘active seekers’ were also the teachers for whom environment and responsibilities seemed to be the ultimate driver for them to further seek research findings. For example, Craig, a deputy principal and responsible for professional development at his school, clearly articulated his view of the school climate:

> *Our school is a school that tends to be innovative and be on the edge of where things are happening educationally … all of us [staff] take that quite seriously in terms of being well-informed practitioners ourselves. We are all reading and finding out and learning and modelling … what it is to be a learner, because I think that is really important, [and it] is something that the school feels quite strongly [about], we should be modelling for the kids …what it means to be a lifelong learner. I think that is pretty much the core business for us as well (p. 3).*

Another example is David, in a management position at his school, as the director for teaching and learning feels that he needs to remain abreast of educational research as he explains his school’s ethos:

> *Our school goals are based around improving the learning environment, [providing] a relevant, meaningful curriculum for the students. As a school we are trying to be fairly innovative in how we deal with things … but we’ve really got to up-skill our teachers’ pedagogy (p. 9).*

In addition to their respective school’s environments both Craig and David were in positions of responsibility to disseminate research findings through professional development sessions. At times they presented sessions themselves and at other times they would contract outside experts in to present sessions.

The other two teachers that seemed to be enabled by their environment and responsibilities were Neil and Joel. Neil was unique amongst the interviewees, in that not only was he a Dean and the head of chemistry at his school, but he also tutored chemistry education students at university. He explained that the drivers to keep his educational research knowledge

up to date were in order to share information with the students and also to work with the members of the department at his school. Joel, a head of chemistry, was also unique amongst the teachers interviewed as he had been extensively involved in teacher organisation and teacher learning initiatives in curriculum development and assessment. In these various roles, it was necessary for Joel to remain informed and thus enable him to disseminate current research findings as a presenter at various professional development sessions.

However it also seemed evident that a position of responsibility was not an automatic enabler for an individual science teacher to become a seeker of research findings. One example was Adam, a head of science and chemistry that had been teaching for thirteen years, but stated "I can't claim I spend a lot of time actively seeking it [research findings]" (p. 5). However, Adam explained that he would present a large portion of the professional development in the science department himself, but agreed that educational research had not significantly informed his teaching and that he accessed research findings "not all that frequently" (p. 3).

2. Other enablers

In the interviews, teachers also identified interventions that they had felt would improve their accessibility to research findings and consequently their use of these to inform their teaching. A number of 'enablers' were discussed earlier in the chapter where they were related to constraints in terms of information isolation and teaching day-to-day. Teachers identified more enabling factors, the most popular was a strong preference for summarised versions of academic papers containing applicable information or strategies that could be applied in the classroom without necessitating large amounts of interpretation, as expressed by Clive:

> *Practical ideas are really good… simple, snapshot ideas of things that work in the classroom that teachers can use and we can share with each other and link [to] student learning (p. 5).*

A number of teachers also indicated that they would prefer a website that could be accessed with this type of information and shorter versions of research findings and applications thereof. Due to time limits on teachers reading, teachers felt that the entire paper needed not be published, but supplied links to the full version for those that may have sought it.

Another idea that was mentioned a number of times was the Teacher Fellowship scheme for science teachers. A number of teachers felt that teachers who receive these awards should be required to produce useful strategies and resources that could be made available to all the science teachers in New Zealand.

Degree of self-motivation

The most immediate distinction between individual teachers both during the semi-structured interviews and during analysis of transcriptions was the difference in self-motivation for individual teachers. Some teachers sought to remain abreast and read extensively and other teachers demonstrated little interest.

The following is a comparison of two of the teachers that were interviewed and these were chosen as they seemed to be at opposite ends of both the active ‘seeking’ spectrum and the self-motivation spectrum.

Peter, a second year chemistry teacher, admitted that he did not actively seek research findings; but reading mostly science subject matter and some education research findings that happen to come across his path, not motivated to read on his own. His reasoning was that he felt that he could not get “carried away in trying to find all these things [educational research]” (p. 7) as he had not been able to assimilate and apply in the classroom what he had read already, both from the teaching diploma that he had completed more than two years previously and also what he had received and been exposed to in professional development sessions in

two years of teaching. Peter repeated the idea of not been able to assimilate information four times throughout the interview:

> *… but I haven't really digested all of the things I have around me already. If I see stuff, because it happens to be in the staff room, [or] something interesting or I get sent the Chem Ed [NZ teachers journal] or Science Teacher, then I'll flick through it, and if there is something there then great, but I am not actively seeking it out. Again it's that sort of passive thing (p. 7).*

At the opposite end of the motivation spectrum was Clive, previously the head of the science department and was a deputy principal at the time of the interview also heading up the professional development portfolios for teachers at the school. He recognised the need to study further in education, the changes occurring in education and need for continual learning, thus seeking educational research findings that were forefront. This attitude seemed to be the prevailing climate at the school where Clive was deputy principal as he commented when asked about the reasons for completing a Masters in Education, stating:

> *I have always been a person who wants to make decisions based on sound reasoning and research, to be an informed practitioner so that I could make well reasoned, well thought out, justifiable decisions or work as part of a team that can contribute to ideas around the direction of school and direction of education and things like that. I felt fine with my subject knowledge, but not around educational theory that I felt was lacking so I really felt that I wanted get up to speed more (p. 1).*

Clive's knowledge and proactive attitudes seemed to mirror those of his school. The motivating factors were linked to three influences; his personal self-motivation, the school environment and his position of responsibility. This motivation resulted in a commitment to reading research findings, assimilating and applying new information as well as disseminating information to other teachers at his school. This came across very strongly

in the interview with Clive. He indicated in the survey that he had spent two or more hours of reading research per month. When asked what he was currently reading and why he was reading it, Clive reinforced his ideas about education needing constant change:

> *I'm reading it because it aligns with how I'm thinking, but it also challenges me to think about where we can get as a school and what we can be doing to improve ourselves (p. 7)*

Clive also commented on the need for reflective practice and changing one's own teaching:

> *…but in terms of reflective practise, in terms of professional development, I think that is a massive aspect of things that need to come more to the fore in education as well… looking at what is working in the classroom, why that is, what needs to change, what would you do differently ...your own kind of little cycle of things occurring in the classroom ...mini-action research occurring continually in your own classroom (p. 6).*

Clive's reasons for seeking out relevant educational research were both self-driven and school driven. The professional setting; the 'climate' of the school and his colleagues and his responsibilities in various roles had a large influence to motivate him to actively search for, and apply relevant research matter.

4.4. Summary of data analyses

In this chapter the quantitative and qualitative data analysis from the questionnaires were initially presented. Subsequently the qualitative data from the semi-structured interviews was presented using grounded theory analysis. In this last section of chapter four, the analyses will briefly be jointly discussed and compared.

The demographic characteristics of both the participants that completed the questionnaire and subsequently those that volunteered to be

interviewed were teachers with a range of teaching experiences, from second year teachers to participants with 30 plus years of experience in science teaching. Nearly half of the sample that completed the questionnaire were science teachers only, with the remaining 20 science teachers also having responsibility in a variety of leadership positions. Similarly, in the sample of nine interviewees, four were science teachers without further leadership responsibilities and five teachers with more years of teaching experience were in positions of responsibility.

Although questionnaire participants agreed that they had access to professional journals, professional development sessions and to the internet, the use of these sources for research findings differed greatly, as shown by the types of seekers in the interview data analysis. Teachers with more years of experience and those in positions of responsibility were also those that indicated they frequently sought research findings and could explain ways in which they had applied findings. Erratic seekers sought were categorised as such due to their sporadic access to research findings and passive seekers readily admitted that they did not actively seek findings but occasion read something if they encountered published research. Moreover, the frequent application of research findings to teaching practice was less than one third of the teachers in the questionnaire and four out of nine teachers interviewed.

From both the questionnaires and the semi-structured interviews, the ways in which accessing research findings informed teachers' pedagogy were influenced by factors such as collegiality and school learning communities, teacher focus, the type of seeker, opportunities for teacher learning through professional development, postgraduate study and constraints to access of published material. The lack of time was the single most identified constraint, followed by a lack of knowledge to how to access and ability to access journals.

It was primarily the participants that had been involved with post-graduate theses or had involvement in teacher organisations and leading professional development sessions that required further knowledge, had

been influenced by what they had read and were able to identify numerous changes in their own pedagogy and teaching practice as a result of research findings applied to their practice. For those teachers that did not spend as much time reading, professional development sessions and conferences were indicated to be the primary source of information for research findings. Interviewees supplied examples of changes that they acknowledged had resulted from research findings have been from a range of identified sources, varying from the impact of a dissertation or thesis involvement to information gleaned from conferences (and further searching on the internet) and information from other professional development sessions. It is important to note that most of the dramatic changes in teachers' pedagogy and practice required extensive further reading and interaction with research findings and none of the changes were sited to have occurred as a result of simply reading of a small amount of research findings.

The factors identified that influenced teachers' motivation to access research findings were categorised into three themes; drivers, enablers and self-motivation. Teachers that expressed a need to remain abreast of educational or science subject specific knowledge also indicated that this was there driver to search for topical, current and relevant information. The enablers that were influential in motivating teachers to seek research findings were related to environment and responsibilities for professional development of others, teacher learning initiatives and leading roles in their school. Other factors that teachers indicated would assist them in accessing and using published research related to a need for a website or hub containing accessible, summarised versions of academic papers with relevance to teaching. Self-motivation related to the amount of interest individual interviewees indicated they had in accessing and using research findings.

This chapter has presented the findings of the questionnaire and semi structured interviews. In summary, the questionnaire and semi structured interviews have revealed the types of research findings that are accessed

by science teachers, what factors motivate them to do so and have identified for this sample of teachers how the research findings may or may not have informed their pedagogy or practice.

Chapter Five

Discussion and Implications

5.1. Introduction

This concluding chapter of the research study begins by collectively compiling the research design and research findings from the previous chapter and makes comment on these in light of the relevant literature with regard to the original research questions. Thereafter is a critical reflection and examination of the limitations of this study followed by the overall significance and implications of this research study as it is contributed to by the theoretical base of interpretative inquiry. Finally the implications for teachers and education researchers are discussed as well as the recommendations for future research.

5.2. Research design

From the outset, the three primary objectives of this study have been to determine in what ways research findings are accessed by science teachers; what science teachers report influences the ways in which research findings inform pedagogy and practice; and the factors that affect teachers' motivation to access research findings and develop as reflective practitioners.

A questionnaire was administered to science teachers attending a chemistry teachers' conference. Included on the last page of the questionnaire was an invitation for teachers to volunteer for an interview to be conducted a few months later. Thirty-five teachers completed the questionnaire and nine participants were interviewed. The data gained from the questionnaires was used to enhance the interview questions and incorporate issues that were identified in the questionnaires such as the instances in which teachers perceived they had used research findings from professional development opportunities, the regularity of conference

attendance and the reasons for teachers not spending time reading published material even though they recognised the need to keep knowledge up to date, thus gaining richer data to answer the three research questions.

5.3. Discussion of findings

The previous chapter presents a comprehensive analysis of the findings from both the questionnaire and the semi-structured interviews. Following in this chapter is a discussion of these findings as related to the three research questions for this study and highlight findings unique to this study in light of relevant literature.

5.3.1. Research Question one: In what ways are research findings accessed by science teachers?

In this study the majority of teachers indicated an interest in accessing and using research findings in their teaching practice. Teachers indicated that they had access to research findings primarily through professional development sessions, secondly through professional journals and thirdly through the Internet. There has been little research in New Zealand that gives an indication of the types of research findings accessed by science teachers and the ways in which these are accessed.

Professional development

Research findings accessed through professional development opportunities, both internal to the school and provided by outside organisers (for example at conferences) were one of the preferred methods for gaining research findings information as given by the teachers in the questionnaires, in comparison to the other ways of accessing research findings. Although only one quarter of the teachers that had

completed the questionnaires indicated that professional development sessions were their main source of professional learning and a valuable source for gaining referrals or suggestions for further reading of research findings. Most of teachers in the interviews could give at least one example of a new way in which they had applied knowledge gained from professional development in their classrooms as a result. Timperley et al. (2007) also found research that showed that in some cases teachers in New Zealand schools were able to apply key messages from professional development sessions to their classrooms. This was dependent on the learning being adapted to the prior learning needs and disposition of the individuals and groups.

For one third of the teachers interviewed, attending conferences was indicated as their primary or only source of accessing educational research findings. This can be problematic because attending one-off sessions may not have effective impact on teaching learning and changing practice (Timperley et al., 2007). Those teachers that could discuss changes in their teacher learning by giving suitable examples had read further and explained how they had engaged with published material. This concurs with the literature that shows that a deeper, more meaningful interaction with research findings is required to make a significant impact on teaching practice (McNamara, 2002; Timperley et al., 2007).

In addition, some teachers acknowledged that they had no on-going internal professional development offered at their school. Most of those that received internal professional development were provided with development exclusively in one developmental area, but not necessarily in an area that they felt they had need to be developed in, or was useful to them. Mikelskis-Seifert and Duit (2010) and Timperley et al. (2007) show that to be useful to the teacher, professional development sessions should: be meaningful to the teacher in both content and context; typically occur over extended periods of time; be tailored to both the prior learning needs and the disposition of individuals and groups; be locally managed and supported by discourse communities and leadership.

At schools where the ethos focussed on high standards of professional learning, structured professional development was offered regularly and the focus was divided between general educational developments, curriculum or subject based development and more personalised development.

Although in the data, questionnaire participants indicated that conference attendance was a common way to gain both in-depth content and instructional knowledge, very few interview participants indicated that they had used research findings from conferences in their teaching. On the contrary, a number of teachers indicated that they had not been able to apply any information from the chemistry conference they had attended to their teaching.

Attending conferences is one way that interviewees indicated they were able to connect with their professional community of teachers. However, simply interacting with professional communities may not be sufficient to change teacher practice. Timperley et al. (2007) explains that teachers interacting with colleagues and research findings at conferences for too brief a period of time to have a significant impact, unless the teacher was more engaged with information by doing further reading after the conference attendance and reflected on information gleaned. Formal professional development had an impact when interventions took place over an extended period and were meaningful in context as well as the teachers being engaged in their own learning (Hoban, 2002).

However, in the data for this study, internal professional development sessions in instructional knowledge proved to be more successful for two early career teachers (Peter and Elaine) as they were able to give examples of, for example behaviour management that had been applied. These teachers considered this internal professional development had changed their practice and demonstrates that these early career teachers may be more focussed on techniques for ‘surviving’ in the classroom. This resonates with what Killen (2007) stated, that early career teachers may

find reflection more difficult due to their mental capacity being used for thoughts on survival and performance in the classroom.

Professional journals

Almost all of the questionnaire participants indicated that they had some access to professional journals, yet at least four participants indicated in the open-ended questions that there was insufficient access to journals and ten mentioned that journal articles were not written in a way that made them useful in a practical sense for classroom application. These findings confirm what McIntyre (1998) and Gilbert et al. (2003) found, that research may not be of interest to teachers due to its peer-reviewed nature, the academic language in which research is written and format it is presented in. All of these aspects make research findings difficult to access, use and apply for teachers.

Unfortunately in this study, some unreliable data may have resulted due to including the option of ‘occasionally’ in the questionnaire answer choices. Figures that compared the amount that teachers indicated that they were reading and the amount they said they occasionally accessed and used professional journals did not correlate. Hence it is concluded that some teachers may have overestimated the amount that they actually accessed and used journals, and this was further supported by the data that only five teachers often used professional journal in their teaching. Hammerness et al. (2005) also showed that teachers may actually overestimate the depth to which their teaching has changed due to implementation of teacher learning.

A possible explanation for overestimation of reading and accessing research findings became apparent in the interviews when nine interview participants were asked to give examples of research findings that they had accessed and that had informed their teaching. Many of their initial answers were related to accessing and using resources as opposed to research findings informing pedagogy. These findings suggest that

teachers are more aware of resources, especially in their early years of teaching as they are gaining experience and require more resources in their teaching practice. This also links with what Killen (2007) had said about early career teaching using their mental capacity to survive and perform in the classroom.

However, even some of the more experienced teachers initially cited access to resources and some teachers tended to bundle resources together with research findings in their thinking and discussion.

Internet

Few interview participants could give examples of research findings that they had accessed on the Internet and applied to their practice. In addition to that, the point is made in the data analysis of the interviews that because of the way in which some of the participants answered questions, that at least some of the teachers were searching more for resources on the internet than for research findings. Furthermore some participants indicated they were overwhelmed by the sheer volume of research findings and difficulties in not knowing where to search on the internet for relevant information. A suggestion was made by a few participants was that one central source that included a summary of research findings that could be accessed would be useful to them. Teachers indicated that access to professional journals, both in hard copy form and on the internet, was further limited by accessibility to teachers and by subscription costs.

Other sources

Thesis or dissertation study was a prime point of access to research findings for two interview participants. Their interaction and engagement with literature made an impact on their teaching practice. Involvement in

conducting research was cited by Cochran-Smith and Lytle (1999) and McNamara (2002) as a catalyst for teacher change.

Some less utilised formats of gaining research findings were conference papers and school learning communities. Teachers indicated that their access to conference papers was limited and a third of the participants were uncertain about the definition of school learning communities, although many teachers also specified that they gained referrals or knowledge about various research findings and increased their own professional learning by either informal or more formal interaction with colleagues. These findings concur with the situative perspective (Greeno, 1997; Putnam & Borko, 2000; Wallace & Loughran, 2003) which displays how teacher learning can be fostered and encouraged in a social setting, where the focus is not just on the individual, but on learning through interaction with other people. This also reinforces the importance of constructivist view of learning which considers that knowledge is actively constructed using social interaction (Moscovici & Varrella, 2008; Tobin et al., 1994).

Summary

In this study, data showed that the seemingly widely utilised professional development approach of attending occasional conferences, one-off workshops and little internally supported and guided professional development is unsupportive of teacher learning and change. Professional development programmes should be planned carefully to take into account the context of the school; personalised to the needs of teachers to be meaningful; and, planned to take place over an extended period of time.

In addition, teacher development should include training teachers how to use research findings from professional journals, how to engage with findings, reflect on these and their own teaching practice and how findings can be interpreted for their own classroom and context. Training teachers

to access and use research findings from the internet may also be included.

Researchers should be more sympathetic to adapt a portion of their work or published material to include brief summaries of research and theoretical perspectives with application to the classroom, to be directly relative to teachers and classroom practice. This may also be useful if contained in one database such as an Internet site for easier accessibility to science teachers.

5.3.2. Second research question: What do science teachers report influences the ways in which research findings inform pedagogy and practice?

This study established a number of ways that influenced how research findings informed teachers' pedagogy of practice, these were the presence or absence of collegiality and school learning communities teachers; the focus of teachers in seeking research findings and the extent to which they sought findings; the opportunities for teacher learning through professional development (as discussed in section 5.3.1.) and in postgraduate research.

Focus of teacher and type of seeker

The type of seeker an individual teacher portrayed themselves to be, had a link to the ways in which they accessed research findings and how much this informed their teaching and pedagogy. In general, the teachers with more years of experience and in leadership positions were more active seekers of research findings and seemed to be highly reflective in their teaching practice. As discussed in chapter two, effective reflective practise requires more background experiences as a basis (Begg, 1994). In addition constructivism as a learning theory considers prior knowledge as a valuable basis from which to construct and interact with new

knowledge (Begg, 1994; Kennedy, 1997; Timperley et al., 2007). From the interviews it was seen that the more experienced teachers also had specific foci in their reading matter and would target research findings that were relevant to their particular foci.

The less experienced teachers interviewed tended to gravitate to the practical resources as opposed to research findings or rethinking their own practice in light of research findings. Some teachers equated research findings with resources, thus it is likely that some of the teachers were not accessing findings for even half an hour per month or as infrequently as they had indicated in the questionnaires. The implications for infrequent accessing of research findings are that these cannot influence teacher learning. The reason is that change in teaching practice does not occur instantaneously and without extensive engagement with experiences and understandings (Hoban, 2003; Timperley et al., 2007; Wallace & Loughran, 2003). Considering the amount of research findings available and constantly produced, the identified amount of reading may be grossly insufficient to even browse through the current research, let alone it affecting change of teacher pedagogy and practice. The teachers with less teaching experience were not able to give extensive examples of how research findings had informed their pedagogy or practice.

Early career teachers seemed to be more focussed on resources, generally implying in the interviews that educational research had not informed their teaching to a significant extent. Furthermore, reflective practise was not a primary focus for early career teachers. As discussed in chapter two, Killen (2007) said that this may be due to both the mental processing capacity required to perform as a beginning teacher and also the lack of experience required for a basis upon which to reflect.

In addition, two early career teachers felt that the research findings that were compulsory reading in their postgraduate teaching diploma were isolated from the ‘world of teaching’ in that they had not been able to apply the researching findings to the real classroom and teaching practice. The inability for beginning teachers to apply the knowledge gained from

teacher education in their subsequent teaching was also found by Russell and Munby (1991). Furthermore, the two teachers indicated that they were pressured to survive in their early teaching careers, hence had not found the time to review literature received in the teaching diploma in order to ascertain how it could be applied to their teaching.

Presence or absence of collegiality and school learning communities

In the open-ended questions, nearly half the teachers indicated that they developed their in-depth content and instructional knowledge of science teaching through collegiality This social nature of teacher learning (Putnam & Borko, 2000; Wallace & Loughran, 2003) was indicated as an important aspect to the participants in this study. Furthermore, the majority of teachers agreed that the school at which they taught encouraged them to reflect on their science teaching and that they had the opportunities to experiment with new ideas gained from educational research. This indicates that the school environment for reflective practice is available for science teachers to utilise.

Postgraduate research

In ascertaining changes to teaching practice as informed by research findings, it was revealed through the interviews that thesis involvement proved to be a strong motivation for teacher pedagogical changes. Cochran-Smith and Lytle (1999) identified that a teacher involved in conducting research was a likely catalyst for teacher learning and change.

In addition, the data showed that prolonged interactions with information gleaned from further studies or from conferences and other professional development sessions yielded examples of teachers' identified changes in practice. Foremost, dramatic changes in teacher practice were more often the result of required extensive further reading and interaction with research findings, frequently for use in leading professional development

for other teachers or involvement in teacher organisations. None of the changes were attributed to casual browsing of research findings. Teacher knowledge develops gradually over an extended period of time and changes in teacher knowledge cannot be assumed to be instantaneous, but require numerous occasions for learning to occur (Timperley et al., 2007). As discussed earlier in this chapter schools with a balanced, on-going, meaningful approach to professional development had an impact on teacher learning.

Constraints

Nearly all the teachers that completed the questionnaire recognised the need to remain abreast of changes in education thus updating their knowledge of research findings, however this recognition did not translate into action for nearly half of the teachers, as they had indicated that they only spent half an hour or less per month reading research findings. An important constraint that was emphasised in both sets of data is the extreme time restraints experienced by teachers, especially newly qualified teachers. Largely, teachers indicated that they simply did not have the time to read, absorb and evaluate how to apply the findings in a practical sense. Research findings may have a greater impact on teachers' practice if more opportunities and time opportunities were given to teachers to take advantage of what research can offer and this links with other findings by researchers such as McIntyre (1998), Timperley et al. (2007) and Gilbert (2003).

But reflective practice requires time and the mental capacity to process information and in this study the fatigue caused by the day-to-day demands of teaching in general inhibited teachers' ability to interact with research findings. Participants expressed that there was insufficient time to perform extensive research findings searches, read through full articles and also interpret findings to be applied to their own teaching in the

classroom. This reinforces the view in the literature of the need for more time to reflect (Killen, 2007).

A significant number of the constraints mentioned by teachers in the open-ended questions of the questionnaire were again mentioned in the interviews. A lack of time was the most influential constraint as identified by teachers with the more recent qualifications, less experienced teachers expressing this most, especially in the interviews. However, those with more experience and in positions of responsibility had mentioned time limitations less emphatically.

Other constraints were such as information isolation were identified by most of the interview participants and these included isolation from work done by education researchers in both a physical and mental sense, isolation due to poor circulation of journals within schools, an exclusion from the world of researchers and research findings that teachers indicated were aimed at academia with little relevance to them and the fourth type of constraints identified was related to the inapplicability of research findings from teachers' post graduate teaching diploma

Teachers felt excluded from the world of research findings that were aimed at academia. The lack of relevance of educational research to teaching, lack of access to relevant research findings and the lack of applicability of research findings was problematic for nearly all teachers irrespective of their amount of teaching experience. Many of the teachers in the interviews indicated that to assist relevance, their expectations from research findings were for articles that would be easier to access, be in a summarised form and with applicable teaching information.

Summary

The deep changes in teacher practice occurred for teachers involved with post-graduate theses or had involvement in teacher organisations and leading professional development sessions that required further knowledge, and had been reflective about what they had read and their

teaching practice. For those teachers that did not spend as much time reading, professional development sessions and conferences were indicated to be the primary source of information for research findings and changes to teacher practice were identified from these.

Identifying the ways that research findings had informed pedagogy and practice of science teachers has been less straightforward than assumed. Having a teacher identify and talk about changes they have made to their practice as a result of research findings has shown that in general teachers do not make deep changes in their teaching unless they engage significantly with literature and reflect a great deal on literature and on their teaching practices related to the research findings.

According to the questionnaires, science teachers had widespread confidence in their own pedagogical content knowledge (PCK), agreeing that they had a deep content knowledge of the science subjects and that they had the instructional knowledge to assist their students to understand the science subjects that they taught. However, twenty three percent of teachers answered that they were less certain of their knowledge regarding alternative conceptions, which was a little surprising as literature relating to alternative conceptions in science has been developed extensively over more than the last two decades. Considering that PCK includes an understanding of what impacts the learning of specific topics for students and also includes the preconceptions, which may include misconceptions, of students, it is concerning that teachers considered themselves lacking in knowledge of these misconceptions and useful strategies likely to organise learner understanding.

5.3.3. Third research question: What are the factors that affect teachers' motivation to access research findings and develop as a reflective practitioner?

The factors affecting teacher's motivation to access research findings and develop as reflective practitioners from the data analysis in this study are discussed in relation to relevant literature. It was found that factors affecting teacher motivation were drivers, enablers and degree of self-motivation.

Drivers

The reasons some teachers gave for seeking research was to remain informed, as both education and science were seen to be 'evolving'. Teachers expressed that they had a desire to improve their teaching for student learning. For some teachers, these reasons were also linked to development in the profession and to fulfil leadership responsibilities. The teacher-leaders that were interviewed were largely self motivated to remain abreast and fulfil responsibilities. As was shown in chapter two, effective professional learning of teachers in the school environment has been linked with supportive school leadership to allow expansive learning environments for teachers (Hodkinson, 2009; Timperley et al., 2007).

Teacher-leaders that were required to lead professional development sessions explained how they disseminated knowledge of research findings and these varied from informal discussions with colleagues to department meetings and formal professional development sessions.

Enablers

Considering the small convenience sample of interviewees, teachers with higher science degrees (a master's or doctorate) seemed to be more active seekers if they were also in positions of responsibility and had more than a decade of teaching experience. Involvement in a dissertation or

thesis certainly motivated teachers in the sample interviewed to become more aware of research, in both using research findings, or ‘engaging with research’ and also doing research or ‘engaging in research’, terms coined by McNamara (2002, p. 4).This engagement in and with research was a powerful enabler for professional learning for the practitioners that had recently completed theses.

However, qualification was not an automatic enabler. In two cases, teachers interviewed with a higher teaching degree (masters or doctorate) were active seekers, thus more inclined to access and use research findings. The highest teaching degree for the other seven participants was a teaching diploma and yet the tendency and appetite for research findings varied greatly amongst the seven, as shown in the section on ‘seekers’ in chapter four, hence it was concluded that a teaching diploma was not an automatic enabler for seeking and using research findings.

Degree of self-motivation

The interview data in particular showed that teacher learning and thus change is intrinsically driven and largely dependent on the individual teachers’ disposition. This was true for the active seekers that made efforts not only to keep their own knowledge up to date, but also to work with their colleagues to develop teacher learning.

Change required time and dedication to actively engage with research findings and to eventually effect change in pedagogy and practice. Most but not all of the teachers with more than a decade of experience and in positions of responsibility were seekers of research. In addition to this, those that could identify and explain definite changes to teaching practice, were all self-motivated to remain abreast, develop professionally and make changes to their pedagogy and practice over time. These findings resonate with what Hodkinson (2009) found about effective teacher learning, namely the disposition of an individual teacher to orientate a person to their own learning.

The best examples of changes in practice were given by teachers that had 20 plus years of experience but more importantly, were able to demonstrate how they had invested time and energy to remain abreast. These teachers demonstrated long-term effort in their professional development and took responsibility for their own learning; these were reflective practitioners and, more importantly worked collaboratively with other teachers in disseminating findings. These findings agree with work carried out by Hoban (2002) regarding these factors and how they affect individual teacher learning.

5.3.4. Summary

Changes in teaching practice and pedagogy are intrinsically driven by the individual teacher and change also takes time. Change requires more than just reading an article or professional journal, teachers need to interact and engage with research findings. For most teachers that may not necessarily embark on a thesis or dissertation, it seems best done through frequent internal professional development sessions where there is support to develop teacher thinking, through regular engaging with and reflection on research findings and their applications to teaching, to enable change.

The findings in this study indicate that professional development for teachers must be better planned to consider the personalised needs and context of the teacher and to take place over an extended period of time, with support. Professional development should include training teachers to engage with research findings and interpreting and discussing findings and their implications for teaching as well as the implementation in the teachers' context.

Research intended to impact teachers should be written with the teacher audience in mind, thus including summaries and applications to the classroom. Improved accessibility to the teacher audience also needs to be addressed on a larger scale.

From these reports, the primary motivation and drivers that science teachers require to remain abreast and read extensively may be related to experience in science teaching and teachers' positions of responsibility. Thus beginning teachers require good professional leaders and mentors to assist them with guidance, motivation and support to make the best use of research findings as they gain experience and to impact on their teaching practice, commencing in teacher education before even teaching in the classroom.

Implications of these factors

Without significant changes to the way research findings could be accessed and the format of presenting them, most teachers expressed that literature and findings were inaccessible and also irrelevant to their teaching.

In order for research findings to inform pedagogy and practice teachers need to seek research, be able to access it and have time to engage with it. In order to do so more effectively, relief time to read and reflect on findings is essential, and support is required to make sense of theory as applicable to teaching practice.

5.4. Limitations

In this study the researcher acknowledges that the teachers were all chemistry teachers that also taught science and all at a conference for chemistry teachers as a self-selected group that volunteered to take part in the questionnaire and furthermore in the interviews. This may have influenced the data gathered, as the participants may have been more willing than those that did not take part to share their views about research findings affecting practice.

Further limitations may have been the sample size and convenience of the sample used as these may have been already more enthusiastic or

personally motivated than other teachers in similar school. Although the teachers were from various geographical locations in New Zealand, the researcher considers that there may be teachers not at the conference that had even less access to professional learning and unable to attend conferences.

All of the information given by teachers answering questionnaires and interview questions were their own interpretations of teaching and opinions of how quality of learning in their classroom were affected. Another limitation of this study is that teachers could not be observed in their classrooms to determine how changes in their pedagogy had influenced student learning, but those teachers' perceptions and reporting of these changes were the only aspect considered.

5.5. Overall Significance and Implications

This research has implications for teachers, researchers, professional development providers and publishing houses. Teachers who engage with research findings to inform their pedagogy should in turn improve student learning.

This study has shown that the most experienced teachers in positions of responsibility have actively engaged with research findings and in some cases have actually done their own research, which had the largest impact in changing teacher pedagogy and practice. The teachers' own attitudes and beliefs about educational research and disposition to professional learning will determine their motivation to engage with research. Ways to motivate teachers that do not already have a positive disposition to professional learning need to be focussed on.

This research shows that researchers may assist by acknowledging that teachers may not have the knowledge of terminology and or the time required to review extensive literature, thus researchers should be more inclined to adapt their writing to appeal to a teacher audience. Researchers should carefully consider the format and language that

teachers may find applicable to their classrooms, what is needed by those in practice and assist by providing suitable, applicable and accessible research findings.

Assuming that science teachers' understandings and pedagogy of science teaching have been constructed over time, and developed by social and experimental encounters, and are local to context and specific to culture, it is vital that professional development providers evaluate how to present research findings for teachers so that they are able to apply them to their teaching practice. Publishing houses should also consider ways to make published material more accessible to teachers.

Teacher training, both at pre-service and at an in-service level, should focus on training teachers in how to use professional journals, evaluating what can be applied to their own teaching and using literature relevant to their teaching, thus training could be tailor made to suit specific needs of individuals. This should equip teachers with skills to continually update their own knowledge effectively, so that perceived limitations to access can be addressed and teachers can familiarise themselves with availability of published materials. A strong recommendation to teacher education would be to engage pre-service teachers in research projects as part of teacher training.

5.6. Recommendations for future research

It is recommended that future research to investigate observe actual changes in teacher pedagogy and practice in the classroom as a result of engagement with research findings. This should be linked with a determination of whether it links with changes and improvement in student learning.

Further research is needed to identify factors that motivate and improve science teachers' dispositions to professional learning. In addition, more

research, extending that done by Hume and Berry (2011), could be carried out on the ways pre-service and early career teachers could be supported to apply research findings to classroom teaching as they are developing their practical classroom practice and pedagogy.

5.7. Conclusion

This final chapter has constructed a discussion connecting the research design and research findings with the research questions. The limitations of this study were detailed as it was influenced by the theoretical base of interpretative inquiry. The overall significance and implications for a variety of stakeholders were examined, as well as the recommendations for future research.

References

Baird, J. R. (1992). Collaborative reflection, systematic enquiry, better teaching. In T. Russell & H. Munby. (Eds.), *Teachers and teaching: from classroom to reflection* (pp. 33–48). London: Falmer Press.

Barber, M., & Mourshed, M. (2007). How the world's best-performing school systems come out on top. Retrieved from http://www.nctq.org/p/publications/docs/mckinsey_education_report.pdf

Barbour, R. S. (2008). *Introducing qualitative research: A student's guide to the craft of qualitative research*. Los Angeles: Sage Publications Ltd.

Barnes, D. (1992). The significance of teachers' frames for teaching. In T. Russell & H. Munby. (Eds.), *Teachers and teaching: from classroom to reflection* (pp. 9–32). London: Falmer Press.

Begg, A., J. C. (1994). *Professional development of high school mathematics teachers* (Unpublished Doctor of Philosophy thesis). University of Waikato, Hamilton, New Zealand.

Bell, B., & Gilbert, J. (1994). Teacher development as professional, personal, and social development. *Teaching and Teacher Education*, *10*(5), 483–497.

Bell, B., & Osborne, R. (1981). Interviewing children: a checklist for the I.A.I. (interview about instances) interviewer. University of Waikato, Hamilton, New Zealand.

Bell, J. (2010). *Doing your research project: A guide for first time researchers in education, health and social science* (5th ed.). Maidenhead, England: Open University Press.

Best, J. W., & Kahn, J. V. (2006). *Research in education* (10th ed.). Boston: A & B/Pearson.

Borko, H. (2004). Professional development and teacher learning: mapping the terrain. *Educational Researcher*, *33*(8), 3–15.

Borko, H., Liston, D., & Whitcomb, J. (2007). Genres of empirical research in teacher education. *Journal of Teacher Education*, *58*(1), 3–11. doi:10.1177/0022487106296220

Boud, D., Keogh, R., & Walker, D. (1985). *Reflection: Turning experience into learning*. London: Open University.

Bouma, G. D., & Ling, R. (2004). *The research process* (5th ed.). South Melbourne: Oxford University Press.

Brew, A. (2006). *Research and teaching: beyond the divide*. New York: Palgrave Macmillan.

Bryman, A. (2001). *Social research methods*. Oxford: Oxford University Press.

Burns, R. B. (2000). *Introduction to research methods* (4th ed.). Melbourne: Longman.

Cochran-Smith, M., & Lytle, S. (1999). The teacher research movement: A decade later. *Educational Researcher*, *28*(7), 15–25.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). London: Routledge.

Davidson, C., & Tolich, M. (Eds.). (2003). *Social science research in New Zealand: Many paths to understanding* (2nd ed.). Auckland, New Zealand: Pearson.

Delamont, S. (1992). *Fieldwork in educational settings: Methods, pitfalls, and perspectives*. London: Falmer Press.

Deng, Z. (2007). Transforming the subject matter: Examining the intellectual roots of pedagogical content knowledge. *Curriculum Inquiry*, *37*(3), 279–295.

Dewey, J. (1938). *Experience and education*. New York: Collier Books.

Dowling, P., & Brown, A. (2010). *Doing research/reading research: re-interrogating education* (2nd ed.). London: Routledge.

Duscl, R. (2008). Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education*, *32*(1), 268–291. doi:10.3102/0091732X07309371

Eisenhart, M. (2006). Representing qualitative data. In J. L. Green, G. Camilli, & P. B. Elmore (Eds.), *Handbook of complementary methods in education research* (pp. 567–581). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Elbaz, F. (1983). *Teacher thinking: a study of practical knowledge*. London: Croom Helm.

Fensham, P. J. (2004). *Defining an identity: the evolution of science education as a field of research*. Dordrecht: Kluwer Academic.

Fox, R., White, S., & Kidd, J. (2011). Program portfolios: documenting teachers' growth in reflection based inquiry. *Teachers and Teaching*, *17*(1), 149–167.

Fullan, M. (1993). *Change forces: probing the depth of educational reform*. London: Falmer Press.

Fullan, M. (1999). *Change forces: the sequel*. London: Falmer Press.

Gess-Newsome, J., & Lederman, N. G. (Eds.). (1999). *Examining pedagogical content knowledge the construct and its implications for science education*. Dordrecht: Kluwer Academic.

Gilbert, J. K., De Jong, O., Justi, R., Treagust, D., & Van Driel, J. H. (Eds.). (2003). *Chemical education: towards research-based practice*. New York: Kluwer Academic.

Giles, D. (2011). *Lecture 1: Maintaining 'quality' in educational research: A gentle start [PowerPoint slides]*. Hamilton, New Zealand: Univeristy of Waikato.

Gluckman, P. (2011). *Looking ahead: Science education for the twenty-first century. A report from the Prime Minister's chief science advisor.* Auckland: New Zealand: Office Of the Prime Minister's Science Advisory Committee. Retrieved from http://www.royalsociety.org.nz/2011/04/05/the-state-of-science-education-in-new-zealand-schools-examined-in-new-report/

Gray, D. E. (2004). *Doing research in the real world*. London: Sage Publications.

Greeno, J. G. (1997). On claims that answer the wrong question. *Educational Researcher*, *26*(1), 5–17.

Grossman, P. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.

Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *The Teachers College Record*, *103*, 942–1012.

Guba, E., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 105–117). California: Thousand Oaks.

Guskey, T. (2003). What makes professional development effective? *Phi Delta Kappan*, *84*(10), 748–751.

Haigh, M., France, B., & Forret, M. (2005). Is 'doing science' in New Zealand classrooms an expression of scientific inquiry? *International Journal of Science Education*, *27*(2), 215–226.

Hall, G. E., & Hord, S. (2011). *Implementing change: patterns, principles, and potholes* (3rd ed.). Boston: Pearson.

Hammerness, K., Darling-Hammond, L., & Bransford, J. (2005). How teachers learn and develop. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: what teachers should learn and be able to do* (pp. 358–389). San Francisco, CA: Jossey-Bass.

Hargreaves, D. (2000). Teaching as a research-based profession: possibilities and prospects. In B. Moon, J. Butcher, & E. Bird (Eds.), *Leading professional development in education* (pp. 200–220). Routledge.

Hinds, D. (2000). Reserach Instruments. In D. Wilkinson (Ed.), *The researcher's toolkit: the complete guide to practitioner research* (pp. 41–54). London: RoutledgeFalmer.

Hitchcock, G., & Hughes, D. (1995). *Research and the teacher: a qualitative introduction to school-based research* (2nd ed.). London: Routledge.

Hoban, G. F. (2002). *Teacher learning for educational change: a systems thinking approach*. Buckingham: Open University Press.

Hoban, G. F. (2003). Changing the balance of a science teacher's belief system. In J. Wallace & J. Loughran (Eds.), *Leadership and professional development in science education: new possibilities for enhancing teacher learning* (pp. 19–33). London: RoutledgeFalmer.

Hodkinson, H. (2009). Improving schoolteachers' workplace learning. In S. Gewirtz, P. Mahony, I. Hextall, & A. Cribb (Eds.), *Changing teacher professionalism: International trends, challenges and ways forward* (pp. 157–169). New York: Routledge.

Hume, A., & Berry, A. (2011). Constructing CoRes - a strategy for building PCK in pre-service science teacher education. *Research in Science Education*, *41*(3), 341–355.

Jenkins, E. . (2001). Research in science education in Europe: Retrospect and prospect. In H. Behrendt, H. Dahncke, R. Duit, W. Graber, M. Komorek, A. Kross, & P. Reiska (Eds.), *Research in science education - past, present and future* (pp. 17–26). Kiel, Germany.

Jones, A., & Baker, R. (2005). Curriculum, learning and effective pedagogy in science education for New Zealand: Introduction to special issue. *International Journal of Science Education*, *27*(2), 131–143.

Kelleher, J. (2003). A model for assessment-driven professional development. *Phi Delta Kappan*, *84*(10), 751–756.

Kempa, R. (2002). Research and research utilisation in chemical education. *Chemistry education: research and practice in Europe*, *3*(3), 327–343.

Kennedy, M. M. (1997). The connection between research and practice. *Educational Researcher*, *26*(7), 4–12.

Khoo, E., & Cowie, B. (2011). Cycles of negotiation and reflection: a negotiated intervention to promote online teacher development. *Educational Action Research*, *19*(3), 345–361.

Killen, R. (2007). *Effective teaching strategies* (3rd ed.). Melbourne: Thomson.

Kvale, S. (2007). *Doing interviews*. Thousand Oaks, CA: Sage Publications.

La Pelle, N. (2004). Simplifying qualitative data analysis using general purpose software tools. *Field Methods*, *16*(1), 85–108.

Labudde, P. (2008). The role of constructivism in science education: yesterday, today and tomorrow. In S. Mikelskis-Seifert, U. Ringelband, & M. Bruckmann (Eds.), *Four decades of research in science education: from curriculum development to quality improvement* (pp. 139–155). Munster: Waxmann.

Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N., & Hewson, P. W. (2010). *Designing professional development for teachers of science and mathematics* (3rd ed.). Thousand Oaks, CA: Corwin Press.

Louden, W. (1991). *Understanding teaching: continuity and change in teachers' knowledge*. London: Cassell.

Loughran, J. J. (2007). Science teacher as learner. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 1043–1065). New Jersey: Lawrence Erlbaum Associates.

Loughran, J. J. (Ed.). (1999). *Researching teaching: methodologies and practices for understanding pedagogy*. London: Falmer Press.

Lyons, N. (Ed.). (2009). *Handbook of reflection and reflective inquiry: mapping a way of knowing for professional reflective inquiry.* New York: Springer.

Mackenzie, N., & Knipe, S. (2006). Research dilemmas: paradigms, methods and methodology. *Issues in Educational Research*, *16*(2), 193–205.

Maykut, P. S., & Morehouse, R. (1994). *Beginning qualitative research: a philosophic and practical guide*. London: Falmer Press.

McIntyre, D. (1998). The usefulness of educational research. In J. Rudduck & D. McIntyre (Eds.), *Challenges for educational research* (pp. 188–206). London: Paul Chapman.

McNamara, O. (Ed.). (2002). *Becoming an evidence-based practitioner: a framework for teacher-researchers.* London: RoutledgeFalmer.

Melville, W. (2010). *Professional learning in a school-based community of science teachers*. Rotterdam: Sense Publishers.

Mikelskis-Seifert, S., & Duit, R. (2010). Various means of enacting a program to develop physics teachers' beliefs and instructional practice. In M. F. Tasar & G. Cakmakci (Eds.), *Contemporary science education research: preservice and inservice teacher education* (pp. 303–311). Ankara: Pegem Akademi.

Millar, R. (2003). Presential address: What can we reasonably expect of research in science education? In D. Psillos, P. Kariotoglou, & V. Tselfes (Eds.), *Science education research in the knowledge-based society* (pp. 3–8). Dordrecht: Kluwer Academic.

Millar, R., Leach, J., & Osborne, J. (Eds.). (2000). *Improving science education: The contribution of research*. Buckingham: Open University Press.

Ministry of Education. (2011). School decile ratings. Retrieved May 13, 2012, from http://www.minedu.govt.nz/

Mitchell, I. (1999). Bridging the gulf between research and practice. In J. J. Loughran (Ed.), *Researching teaching: Methodologies and practices for understanding pedagogy* (pp. 44–64). London: Falmer Press.

Morgan, G. A., Leech, N. L., Gloekner, G. W., & Barrett, K. C. (2007). *SPSS for introductory statistics: Use and interpretation* (3rd ed.). Mahwah: Lawrence Erlbaum Associates.

Moscovici, H., & Varrella, G. (2008). International professional development as a form of globalisation. In A. Barton, M. Borba, B. Atweh, N. Gough, C. Keitel, C. Vistro-Yu, & R. Vithal (Eds.), *Internationalisation and globalisation in mathematics and science education* (pp. 285–302). Dordrecht: Springer.

Munby, H., Russell, T., & Martin, A. K. (2001). Teachers' knowledge and how it develops. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed.). Washington, D.C: American Education Research Association.

Mutch, C. (2005). *Doing educational research: A practitioner's guide to getting started*. Wellington, New Zealand: NZCER Press.

Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, *29*(1), 4–15.

Resnick, L. B. (1991). Shared cognition: thinking as social practice. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 1–20). Washington DC: American Psychological Association.

Russell, T., & Munby, H. (1991). Reframing: The role of experience in developing teachers' professional knowledge. In D. Schon (Ed.), *The Reflective turn: case studies in and on educational practice* (pp. 164–187). New York: Teachers College Press.

Schon, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.

Shulman, L. S. (1986). Those who understand: knowledge growth in teaching. *Educational Researcher*, *15*(2), 4–14. doi:10.2307/1175860

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1–22.

Thrupp, M. (2010). The politics of being an educational researcher: minimising the harm done by research. *Waikato Journal of Education*, *15*(2), 119–133.

Timperley, H., Wilson, A., Barrar, H., & Fung, I. (2007). *Teacher professional learning and development: Best evidence synthesis iteration (BES)*. Wellington, New Zealand: Ministry of Education.

Tobin, K., Tippins, D. J., & Gallard, A. J. (1994). Research on instructional strategies for teaching science. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 45–93). New York: Macmillan.

University of Waikato. (2008). Ethical conduct in human research and related activities regulations. *University of Waikato, 2011 calendar, Assessment*. Retrieved January 19, 2011, from http://calendar.waikato.ac.nz

Usher, R. (1996). A critique of the neglected epitemological assumptions of educational research. In D. Scott & R. Usher (Eds.), *Understanding educational research* (pp. 9–32). London: Routledge.

Van Der Merwe, S. (2000). *Preservice science teachers' conceptions of the conservation of matter and related concepts* (Unpublished Project in Education for Bachelor in Education Honours Degree) (p. 37). Johannesburg: University of the Witwatersrand.

Van Kammen, W., & Stouthamer-Loeber, M. (1998). Practical aspects of interview data collection and data management. In L. Bickman & D. J. Rog (Eds.), *Handbook of applied social research methods*. Thousand Oaks, CA: Sage Publications.

Wallace, J., & Loughran, J. (2003). *Leadership and professional development in science education: New possibilities for enhancing teacher learning*. London: RoutledgeFalmer.

White. (1999). Changes in research since 1969. In J. J. Loughran (Ed.), *Researching teaching: Methodologies and practices for understanding pedagogy* (pp. 235–243). London: Falmer Press.

Yager, R. E. (1991). The constructivist learning model. *The Science Teacher*, *58*(6), 52–57.

Zeichner, K. (1995). Beyond the divide of teacher research and academic research. *Teachers and Teaching*, *1*(2), 153–172.

APPENDICES

APPENDIX A: Letter to conference convenor,

May 2010

Dear (conference convenor) _____

Investigation into science teachers' use of research findings to inform teaching.

My name is Suskia van der Merwe and I am commencing a study towards partial fulfilment of a Masters degree at the University of Waikato. The aim of this study is to investigate and explore the use of science education research findings in professional learning and practice. This should help the science research community to better understand the ways in which research findings are accessed and used by teachers to support teaching and learning in the classroom.

For this purpose, an initial data gathering instrument, a questionnaire, is being designed for a number of science teachers to complete in which their views can be expressed. I would like to request permission to place a questionnaire in each delegate's information pack to be distributed at the Chemistry Education Conference in Palmerston North in July 2011. Should this request be approved, sufficient copies of the questionnaire will be supplied to you, by the requested date. I would also like to request a brief 3 minute slot in the conference programme for me to address the delegates. This will enable me to verbally introduce the intent of this research and express appreciation for any voluntary involvement.

The questionnaire can be done by the delegates in their own time and will take at most 15 minutes to complete. They will be asked to submit the questionnaire before the end of the conference. In addition, there is a request at the end of the questionnaire for an interview at a later date at a time and venue that suits the participant.

The front pages of the questionnaire will give information about the study and request the delegates' voluntary involvement. The identity of the participants will remain confidential, by using pseudonyms in any written reports. The participants may withdraw from this study at any time.

The participants may receive a copy of the final summary of research findings (if they have provided their email address). Findings will be published in a final Masters thesis. In addition, findings may be disseminated through seminars, conference presentations and journal articles. Any work collected for data will not be used in any other way than for the purposes of the project.

Should you have any queries regarding this study, kindly approach Suskia (phone 07 852 5781, email: suskia.douw@vodafone.co.nz) Alternatively, where concerns are not allayed, contact can be made with or either the first supervisor of this study, Dr Kathrin Otrel-Cass (Phone 07 838 4512 , email: kathrino@waikato.ac.nz), or the second supervisor Dr Anne Hume (Phone: 07 838 4466 ext 7880, email: annehume@waikato.ac.nz).

I thank you in anticipation for your response and positive approval.

Yours sincerely

Suskia van der Merwe

Cover letter and Questionnaire

17 July 2011

Dear Science Teacher

Investigation into science teachers' use of educational research findings to inform teaching.

My name is Suskia van der Merwe (also a secondary science teacher) and I am commencing a study towards partial fulfilment of a Masters degree at the University of Waikato. The aim of this study is to investigate and explore the use of science education research findings in professional learning and practice. This should help the science research community to better understand the ways in which research findings are accessed and used by teachers to support teaching and learning in the classroom. It is hoped that the outcome of this research will assist in understanding the impact of educational research in science on teachers' professional practice.

For this purpose, I invite you to complete a questionnaire in which your views can be expressed. The questionnaire should not take more than 15 minutes to complete and you are kindly requested to return completed questionnaires before leaving the conference. A box will be provided at the registration desk for the collection of the questionnaires.

Furthermore, at the end of the questionnaire, you are invited to participate in an interview at a time and place to suit you. If you are willing to be interviewed later in the year, please provide details on the final page of the questionnaire. The interview will be recorded for analysis purposes.

Please be assured that your identity as a participant will remain confidential. Pseudonyms will be used in any written reports and you may withdraw from this study at any time. Data that have been provided prior to withdrawal, but that have already been analysed, will remain in the study. All data will be stored securely.

You may request a copy of the final summary of research findings (please provide an email address for this). Findings will be published in a final Masters thesis. In addition, findings may be disseminated through seminars, conference presentations and journal articles.

Should you have any queries regarding this study, kindly approach Suskia (phone 07 852 5781, email: suskia.douw@vodafone.co.nz). Alternatively, where concerns are not allayed, contact can be made with either the first supervisor of this study, Dr Kathrin Otrel-Cass (Phone 07 838 4512, email: kathrino@waikato.ac.nz), or the second supervisor Dr Anne Hume (Phone: 07 838 4466 ext 7880, email: annehume@waikato.ac.nz).

I thank you for your time in reading this letter and the attached questionnaire. I appreciate your valuable time in responding to the questions.

Yours sincerely

Suskia van der Merwe

Investigation into science teachers' use of educational research findings to inform teaching.

QUESTIONNAIRE CONSENT FORM

Instruction: Please tick the appropriate boxes and supply your full name, signature and date on this document if you feel comfortable taking part in this study.

Consent to take part in the study

☐ I have read and fully understood the information about this study provided by the researcher.

☐ I understand that even if I have initially agreed to take part in the study, I can withdraw consent *at any time* prior to returning the completed questionnaire.

☐ I understand that taking part in this study is voluntary.

☐ I understand that my name will not be revealed in any parts of the research or written report of the research. I also understand that the data will be reported in a way to protect my confidentiality and the data will be stored securely.

Date: _____

Signed:_____ Name: _____

QUESTIONNAIRE

An investigation into secondary science teachers' use of educational research findings to inform their science teaching.

Please feel free to write over the page if more space is required.

Section A: About you, the respondent

A1: Please list your current qualification(s), starting with most recent:

Qualification	Date attained

A2: Cumulative years of teaching experience: _____

A3: Gender: _____

A4: How long have you been teaching at your current school? _____ years

A5: Please indicate which subjects and/or classes you currently teach:

A6: Please indicate your position(s) in the department(s) for the school you are teaching at:

Department	Position

A7: Do you hold responsibility for a specific area within the science department? Please provide a brief overview of the activity or outcome associated with this responsibility.

Section B: About your access to and use of educational research

B1: Listed in the table below are some ways in which science education research is disseminated. Please read through this table to see whether you have access to and are able to use educational research reports in support of your professional development.

	Have access to?		I access the research findings in these sources.			I am able to use the information gained in my teaching practice.			If applicable, please specify one or more titles that have been most useful.
	Yes	No	often	occasionally	never	often	occasionally	never	
Professional Journals e.g. Education Gazette, Chem Ed NZ, SET.	☐	☐	☐	☐	☐	☐	☐	☐	
Conference papers	☐	☐	☐	☐	☐	☐	☐	☐	
Internet	☐	☐	☐	☐	☐	☐	☐	☐	
Organised professional development sessions	☐	☐	☐	☐	☐	☐	☐	☐	
School learning communities	☐	☐	☐	☐	☐	☐	☐	☐	
Other (please specify):	☐	☐	☐	☐	☐	☐	☐	☐	

B2: How many hours on average, per month, would you estimate you spend on reading research findings? Tick the appropriate box.

☐ **none** ☐ **less than ½ hour** ☐ **½ to 1 hr** ☐ **1 to 2 hrs** ☐ **2 or more hrs**

B3: How appropriate are each of the following statements to you? Please tick the most appropriate box for each statement.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I consider myself to have a deep content knowledge of the science subject(s) that I teach	☐	☐	☐	☐	☐
I consider myself to have instructional knowledge or the 'how to teach' required to assist my students to understand the science subject(s) that I teach.	☐	☐	☐	☐	☐
I am thoroughly aware of the alternative conceptions (misunderstandings) that students may have with some science concepts.	☐	☐	☐	☐	☐
I recognise the need to update my subject knowledge by reading educational research.	☐	☐	☐	☐	☐
I gain valuable information from educational research, which I usually try to translate into practice in my classroom.	☐	☐	☐	☐	☐
I actively seek educational research that is relevant to my teaching.	☐	☐	☐	☐	☐
I have opportunities to experiment with new ideas gained from educational research in my teaching practice.	☐	☐	☐	☐	☐
Much of what I read in science education research can be applied to my teaching.	☐	☐	☐	☐	☐

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Most of my referrals/suggestions for educational research are gained from attending courses/ professional development.	☐	☐	☐	☐	☐
Most of my referrals/suggestions for educational research are gained from colleagues in the school environment.	☐	☐	☐	☐	☐
Most of my referrals/suggestions for educational research are guided or informed by identified teaching problems.	☐	☐	☐	☐	☐
The school at which I teach encourages me to reflect on my science teaching.	☐	☐	☐	☐	☐
I find attending professional development sessions useful when they are underpinned by educational research.	☐	☐	☐	☐	☐

B4: What has been the most useful educational research you heard or read about and why has it been useful to you? (Please consider content, application and perhaps presentation of information)

_____

_____

_____

_____

_____

Section C: About you as a lifelong learner

The next three questions are a reflection on this quotation: "Given the scale of changes that teachers face, it has been argued that teacher professional learning should not just be seen as a constant 'updating' of teachers' knowledge, skills and personal qualities; rather, **teachers should be lifelong learners whose professional learning should be based on "developing and enhancing in-depth content and instructional knowledge"** (Melville, 2010, p. 28)

C1: How do you develop your "in-depth content and instructional knowledge" of science teaching?

C2: Considering your answer above, briefly explain any constraints to your lifelong learning in science teaching.

C3: Considering your professional learning needs, indicate *two* interventions that would support you in your professional development.

Section D: Further comments

If you wish to comment further on teachers accessing and using educational research, please use the space below to share your thoughts.

Section E: If you wish to receive a copy of the final summary of research findings

Email address: _____

Section F: An Invitation for further involvement

Dear teacher,

Thank you for taking part in the questionnaire. At this point I would also like to invite you to take part in a short one-on-one interview to obtain more detailed data.

I hope to gain in depth information from the interviews that should greatly enhance the quality of this research and hopefully inform researchers and practitioners alike about the needs and experiences of teachers with educational research.

If you decide to participate I would contact you in August to make arrangements for an interview at a time and place that are most convenient to you. The interview would take no longer than 30 minutes. Skype could be used to conduct the interview if I am unable to travel to your location or if it suits you better. Should you be willing to be interviewed, I would be grateful if you could provide your details below. I will send you a consent form with detailed information about the interview procedures.

Many Thanks

Suskia van der Merwe

Name: _____

Email address: _____

Access to Skype? Y/N _____

Skype address: _____

Phone number: (_____) _____

APPENDIX B: Cover Letter, Interview Consent and Schedule

11 September 2011

Dear

Investigation into science teachers' use of educational research findings to inform teaching

I would like to thank you for taking part in the questionnaire that you received at the conference and for giving an indication that you would be willing to take part in an interview.

This study is towards partial fulfilment of a Masters degree at the University of Waikato. The aim of this study is to investigate and explore the use of science education research findings in professional learning and practice. This should help the science research community to better understand the ways in which research findings are accessed and used by teachers to support teaching and learning in the classroom. It is hoped that the outcome of this research will assist in understanding the impact of educational research in science on teachers' professional practice.

For this purpose, I would like to interview you on …… via Skype**.** We will confirm Skype contact details a few days before the actual interview. Please feel assured that should your circumstances change and you wish to change this interview date or time, all you need do is send me an email to rearrange.

The interview questions will relate to some of the answers from your questionnaire and also explore more in-depth ideas about your access to and use of educational research findings. The interview will be recorded for analysis purposes.

Please be assured that your identity as a participant will remain confidential. Pseudonyms will be used in any written reports and you may withdraw from this study at any time. Data that have been provided prior to withdrawal, but that have already been analysed, will remain in the study. All data will be stored securely.

I have included an interview consent form and a self-addressed stamped envelope for you to return the consent form. I would be most grateful if you could return this before the interview.

You may request a copy of the final summary of research findings (please provide an email address for this). Findings will be published in a final Masters thesis. In addition, findings may be disseminated through seminars, conference presentations and journal articles.

Should you have any queries regarding this study, kindly approach Suskia (phone 07 852 5781, email: suskia.douw@vodafone.co.nz). Alternatively, where concerns are not allayed, contact can be made with the supervisor of this study, Dr Kathrin Otrel-Cass (Phone 07 838 4512, email: kathrino@waikato.ac.nz).

I thank you for your time to complete and post the consent form and also the time to take part in the interview.

Yours sincerely

Suskia van der Merwe

Investigation into science teachers' use of educational research findings to inform teaching.

INTERVIEW CONSENT FORM

Instruction: Please tick the appropriate boxes and write your full name, sign and date on this document if you feel comfortable to take part in this study.

Consent to take part in the study

☐ I have read and fully understood the information about this study provided by the researcher.

☐ I understand that even if I have initially agreed to take part in the study, I can withdraw consent *at any time before the data is analysed.*

☐ I understand that taking part in this study is voluntary.

☐ I give full consent to record interview responses. I give full consent for the use of interview transcripts for the researcher's masters thesis, publication, seminars and conferences purposes only.

I understand that my name will not be revealed in any parts of the research or written report of the research. I also understand that the data will be reported in a way to protect my confidentiality and the data will be stored securely.

Date: _____

Signed:_____ Name: _____

Outline of Interview schedule

Pre interview / Introduction

Date: _____

Interview with _____ from _____

Discuss: purpose of research, recording, feedback, confidentiality

If not already obtained from questionnaire:

What is your position in the science department? In the school?

Please would you provide some background about yourself (as relevant to your work as a teacher): (or elaborate from questionnaire's answers)

- What do you teach?
- What qualifications do you currently hold?
- How many years of experience do you have in teaching science?
- How many years have you been teaching at your current school?

Interview questions

Discuss understanding of 'research findings' as impacting on 'teacher learning' as pertaining to this study.

1. To what extent do you use research findings to inform your science teaching?

2. Can you describe a way in which research findings have (or have not) contributed to your teacher learning?

3. What (if any) research findings have you been able to use frequently in teaching? Where did you obtain these findings?

4. What do you see as the aspects of your teaching that you have changed? Why have these changes occurred?

5. Do you proactively seek research findings? If so, what makes you look for this information?

6. What have you found to be the most useful format for research findings?

7. From the questionnaire, it seems that the internet is a useful source of research findings for many of the teachers. Do you use research findings from the internet? Where do you go to find research findings on the internet and how easily accessible are these?

8. From the questionnaire a large number of teachers responded that research findings as presented in Professional Development Session were useful to use in teaching? Have you found this to be true?

What types of research findings have been most useful from PD sessions for you? How has it changed your teaching in the classroom?

9. Can you tell me more about the SLC accessible to you?

10. What opportunities does the school provide to enable teachers to reflect on teaching methods and update their teaching strategies?

11. In your opinion, are there any constraints on your development ? Why? (e.g. limited resources, remoteness etc)

12. Which of these changes do you regard as 'critical'?

13. Do you think your practice as a teacher has changed as a consequence of research findings (i.e. based on sound research evidence)? Can you describe this change? Why did it occur?

14. What do you think has caused you to change your teaching strategies?

15. In your questionnaire you indicated that you read on average _____(time) of research findings in a month. Why do you feel the need to read research findings? Do you think this is related to the number of years since your own educational studies?

16. In answer to this question in the questionnaire: "considering your professional learning needs, indicate two interventions that would support you in your professional development", there were two prominent answers (besides time) 1. respondents specify that easily accessible summaries of research and applicable examples would be most useful and 2) many respondents mention that they would like access to more professional support, access to resources or additional funding and resources. What would your opinions be on these interventions?

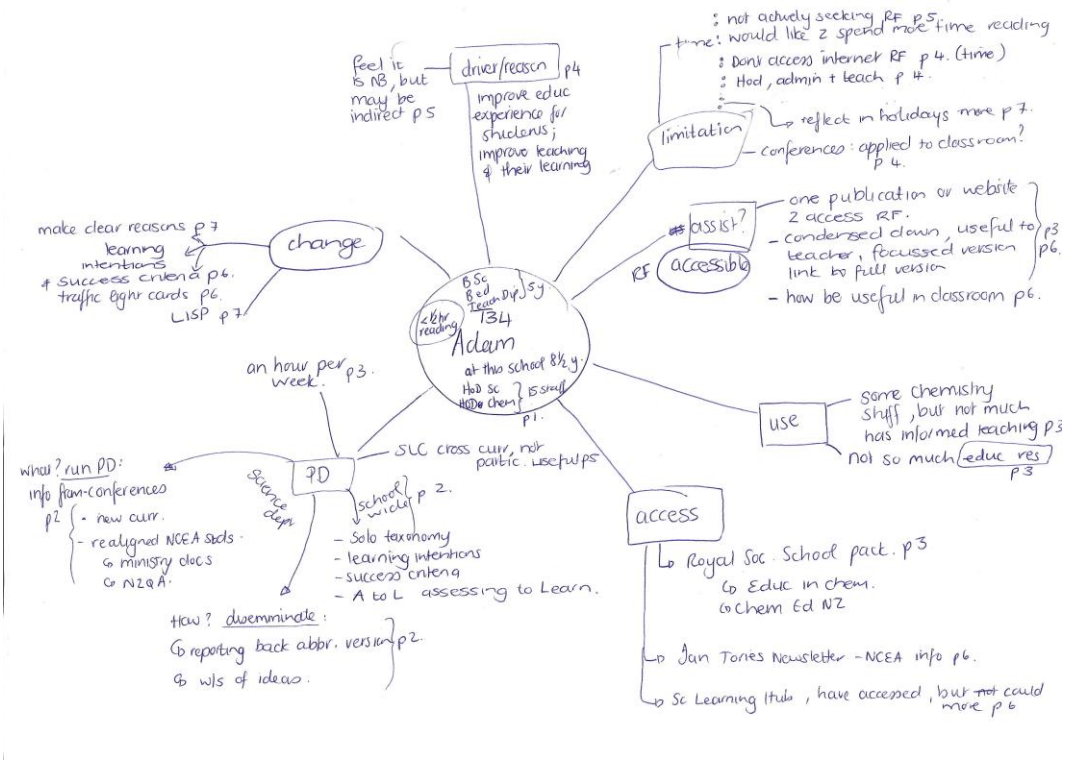
17. Are there other aspects/factors/influences that have impacted on the way you teach science at your school?

18. Which conceptually challenging areas of chemistry do students hold prior knowledge that may impede learning? If you were asked to identify possible misconceptions that students hold, would you be able to do so in each of these areas:

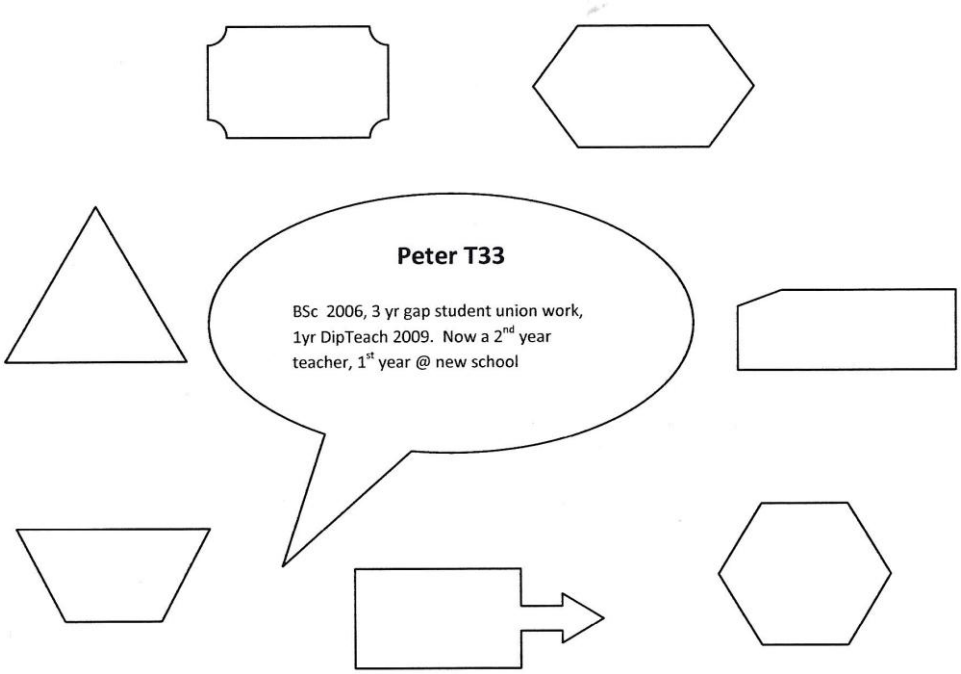
Conceptually challenging areas of chemistry	I would be able to identify ____ possible student misconceptions: many	some	few
e.g. Electrochemistry (including charge laws, electric current, potential difference and e.m.f and oxidation-reduction)			
Particle model of matter			
Add….			

Are these misconceptions that you could identify based on research findings or on experience in the classroom? Explain.

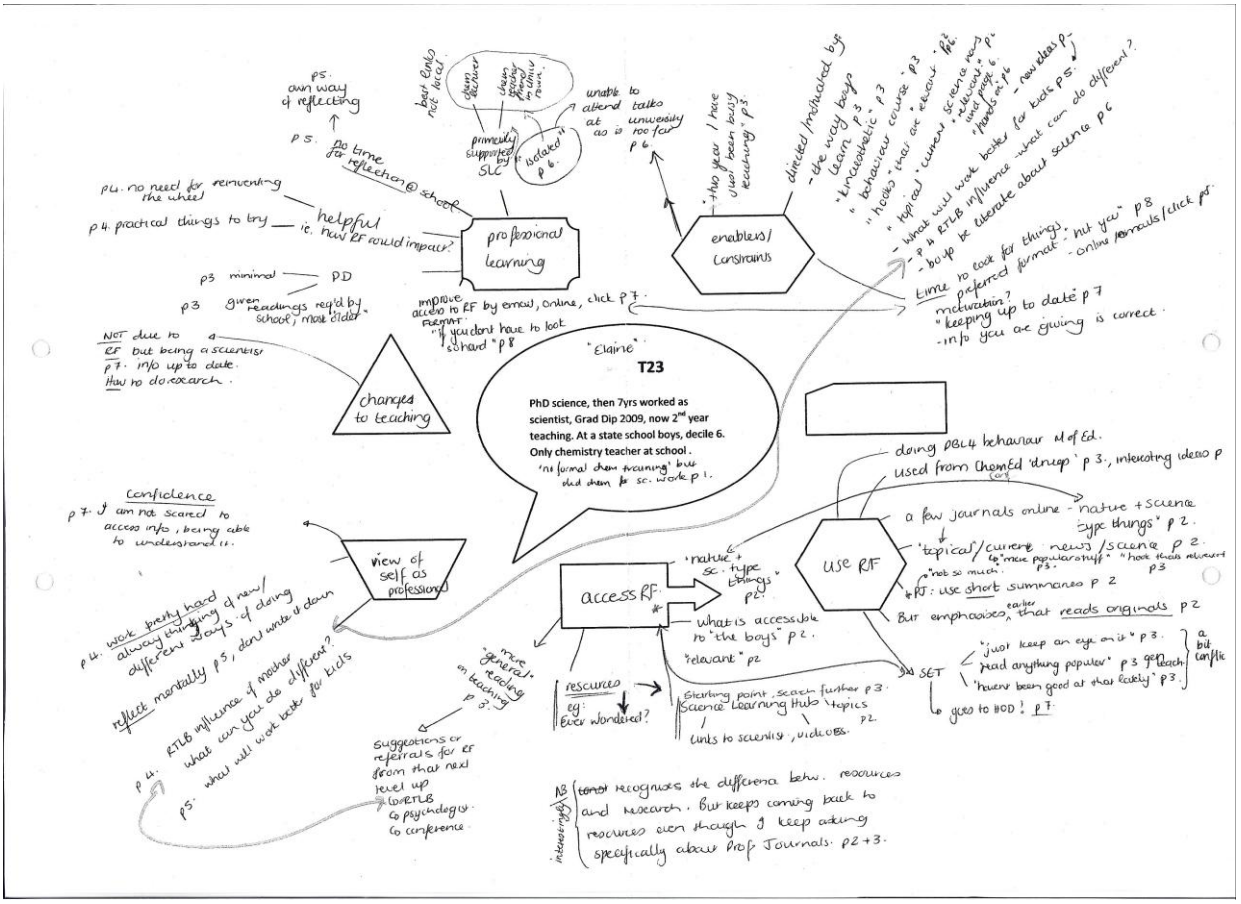
APPENDIX C: Example of a Rough Category Diagram



APPENDIX D : Generic Skeleton Theme Diagram (incomplete)



APPENDIX E : Example of Complete Theme Diagram



APPENDIX F : Matrix Coding Table of Themes

(p1)

Table XI :

	Theme	N = 9	T30	T33	T23	T31	T9	T34	T1	T10	T22
	hrs.		2+	½-1.	2+	< ½	1-2	< ½	2+	1-2	2+
	Search/look for RF:-		Clive	Peter	Elaine	Fred	Sue	Adam	Neil	David	Joel
motive/reason	recognised lack of knowledge	4	p1		p7	p7 to improve learning	unidentifiable p8				
	lifelong learning, education evolves	5	p3, p7						learning cont p4,5	Δ in educ p9 If I don't go conferences	
motive reason	recognises Δ, keep up to speed educt evolves		p1, 3		p5, 6, 7 ✓				✓	I don't stay ahead p6. p9	keep up 2 date p1
motive	(identified teaching problems pupil difficulty, ways 2 improve learning	5	no proactive not reactive		p5 do differently work for them	p4 p2 p7		improve student learning p4	informs my teaching p1 ?		knowing u can do better p1 new ways of delivering p2
motive	work with members of dept								p1 students @ uni p1	part of my job, know what's current p8	
enabler	responsibilities: director, facilitator									p3, 2, 10	
enabler	responsibilities: key role: disseminate + how?	4	p2					p1+2 enabler? p2	dept p1 uni p1	part of my job p8 p7, p3, 10	
enabler	type of school "challenges thinking" core business.. lifelong learner		p1 p3							school strong focus improve learning env.	
constraint	isolated from researchers work/univ no natural translation	6			p2 p6 ✓	p1, 2 3 ✓	'academic land' p8 univ libr p3	aim at academics p3	disjointed p3 divide p5,6 p3 ✓		few applicable strategies p9, 10, 13
constraint	demands of job, time, funding (no time reflect @ school)	9	p6	(p4 p5, 7)	all conferences p4	p4, 3, 1, 7	p7	demands p4 p5, 4 holidays p7	no time to bridge gap p3	time p8	time p11 overtime holidays p12 energy p13
constraint	infrequent circ of mags.	4		Staff room p7	p3 ? p7.	p1 infreq circ	p3 what comes thru staffroom				sticky notes p7
constraint	PJ have to be paid for - access difficult								p2 ✓ insuff subscribed?	subscribe to own SET	
What?	conferences useful/not			not! p3	p3 p5.	relies on conferences p2	no access to papers p3	info disseminated p2, but not applied p2		offered lots useful ideas p6. (pays for)	lots, local + int'l, but sometimes not useful p9, 10
what?	accesses activities/resources.			p7 N2 bubbles p2	p2 hub ever week p4	p2, 4 4	PBGIL p8+9 TED p4	from journals mostly chem p3	both, p2, "quickly"	also	visit links web, discuss p7
what?	read/search for educ R that aligns w thinking		p6						articles I agree with p4		
what?	Journals		Ed gazette chem NZ Sc Teach	NZ Sc Teach Chem Ed Ed gazette "Hip Hop" p4	SET p3	p1 industry magazines "a chem teacher mag" p1.	Chem Ed p3 NZ SCT p3	Chem Ed p3 Ed in Chem p3 RS package	RSC educ package p2	SET p7 NZEJ p7 → apply at [illegible] p7	RSC pack p7 take notes sticky notes.

Focus for this teacher? Educ/Science/Leadership (E S LM)