“MISS, MY BRAIN HURTS!” REWIRING OUR TEACHING PRACTICE

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ABSTRACT

Over the past decade neuroscientists have made more breakthrough discoveries about brain function than in all previous scientific investigation. Educators see brain research as having implications and application to classroom settings by enhancing teacher practice and student learning experience. Tertiary institutions and practising teachers are implementing brain based teaching strategies to improve student outcomes. However, there is a level of disconnect between brain research discovery and current educational practice.

Researchers from both neuroscience and education fields are calling for collaborative research to be conducted that would support classroom practice for the future. Researchers from neuroscience and education insist that appropriate professional development for teachers is imperative and that a serious undertaking for teaching neuroscientific facts should be included in tertiary education student programs.

Pre-service teachers' studying at the University of Southern Queensland (USQ) have learned about current developments in neuroscience research during their final year of teacher training. This research investigates how these newly graduated teachers use brain research in their first year of teaching to inform their classroom practices.

Findings would indicate that in order to encourage the implementation of neuroscience supported practices in classrooms, teachers need to develop an appreciation of educational neuroscience. There were a number of patterns that emerged from the research including the impact of school and community expectation and the need for professional development of pre-service teachers.

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Chapter 1: INTRODUCTION

Background to the research

Neuroscience is a new and little understood field of science for those working beyond the neuroscience field. Neuroscience research may hold information of great importance to the development of new teaching approaches and practices for educators as this field investigates the functions of the brain in learning.

Neuroscience has made discoveries connecting brain structure and functional areas (Goswami & Szűcs, 2011; Varma & Schwartz, 2008), wiring and brain plasticity (Geake, 2004), gender differences in brain development (Haier & Jung, 2008) remedial and specific needs programs (Summak, Summak, & Summak, 2010) and some teaching practice applications to enhance learning (Waterhouse, 2006a). In contrast to researchers connecting brain structure and function, Bruer (1997) has long argued against a quick adoption of neuroscience to education contexts. He believes translation of neuroscience findings is limited in these early discoveries. Several researchers have investigated the scientific validity of currently used teaching practices to find that some practices have no scientific support (Geake, 2004; Goswami & Szűcs, 2011; Purdy, 2008; Waterhouse, 2006a).

The broad variation of opinion and ongoing discovery within the field of neuroscience has encouraged some educators to consider how discoveries may be used to enhance the learning experiences of students. Although limited engagement with neuroscience research has been undertaken by educators, there are many commercial packages now available which adopt brain based techniques derived from these discoveries (Chudler & Konrady, 2006; Jensen, 1998). Perhaps due to the assumption that these packages have been approved and validated for commercial release, some educators and educational institutions adopt these without question. This may also be due to educators respect for the neuroscience field in which they are quite probably not expert. This study explores

the extent to which brain research has been utilised by six first year teachers in their various school contexts.

The researcher is an educator with over 35 years of experience. Understanding brain development and applying this to benefit students is a long standing interest.

Research problem

During Faculty of Education pre-service teachers' study at the University of Southern Queensland (USQ) they have learned about current developments in neuroscience research. This project aims to investigate how these newly graduated teachers are using brain research, in their first year of teaching, to inform their classroom practices. The research questions this project seeks to examine are as follows:

- How are first year teachers' teaching practice decisions influenced by their prior university learning and their current school context?

- To what extent, if any, do first year teachers incorporate and implement neuro-scientifically supported practices in their teaching program?

Contribution to the field

There is a growing body of research about how the brain works and learns. Some of this information is applicable to the educator and may ultimately affect teachers' pedagogical choices. This study aims to follow early teacher articulation of tertiary study learning to the teaching context, with a particular focus on brain theory research and its implementation. It is anticipated that this study will inform educators and neuroscientists about how prior university learning and subsequent teaching context affects the way teachers choose to teach. In addition, this research will be underpinned

by current neuroscience research with a specific focus upon the brain's learning functions in the context of education.

The research will also provide an important opportunity for the researcher to understand the impact of their tertiary teaching practices and the effectiveness of the lecturer - student model in this context.

Justification for the research (the gaps)

Whilst there is a growing body of research about how the brain works, the researcher could find only limited research that investigates the influences that affect the pedagogical choices of educators. The literature in this area appears to be even more limited when the pedagogical approaches chosen by teachers are from the field of neuroscience, and specifically, brain based practices which can be applied to education settings.

The literature review in Chapter Two investigates common themes in the links between neuroscience and education and finds a high degree of consternation over some educators' adoption of neuroscience findings based on a surface knowledge of this field. In more recent years the discussion has turned to the importance of educators and neuroscientists forging stronger links and further developing an understanding of the other context, either education or science.

In so attempting to develop an appreciation of the alternate field it has been proposed that training and professional development for educators around neuroscience and brain based learning is important. This study is an attempt to fill this gap and inform both fields of findings that may inform future sharing of neuroscience findings for teachers and how they can effectively apply these findings through their pedagogical practices in the classroom context.

Methodology

A case study methodology was used to interview six individual first year teachers, with their classroom context taken into account. Two interviews were conducted with each teacher approximately 10 weeks apart. Each interview contained a schedule of semi-structured questions to establish consistency but also to allow scope for further exploration of participants' answers if required.

Photographs of the participants' classroom contexts and personal philosophy statements were also collected, in addition to the interviews for corroboration and triangulation purposes. Visual analysis of the photographs was undertaken to determine how each of the participants creates a working environment for their students and provided important information in relation to their theoretical awareness and implementation of how learning occurs. The photographs were also used in the interviews as artefact elicited prompts to further explore the participants understanding of brain research. Personal philosophy statements were used as artifact elicited prompts to consider alignment of belief statements written during university study with teacher's current teaching practices.

Patterns and themes in the data were sought and coded to determine similarities and dissimilarities between the interview information given by the participants. Like themes were colour coded across interviews and participants. Categories were developed from repeating themes (three or more occurrences) and neuroscience research findings (taken from the review of literature in Chapter 2). All data was also double coded to provide greater reliability to the data analysis.

Delimitiations

This case study was conducted over a restricted timeframe and all results are pertinent to this period in time. Findings cannot be extrapolated beyond the case study participants who were first year teachers newly appointed to primary school settings with only six months previous teaching experience. The case study sought to observe the influences on teacher selection of pedagogy from their context and university learning with a particular focus on the study of neuroscience and its application to teaching.

Conclusion

This introductory chapter provides a brief overview of a current, intriguing and rarely investigated field of research. The chapters that follow will systematically draw the reader through the process undertaken by the researcher to address the study of early teacher pedagogical practices and look closely at the impact that school context and university learning has upon this selection of pedagogy. The research will also drill into the pedagogy in order to identify neuroscience based pedagogical choices.

The study begins with a review of the literature discussing neuroscience discovery and the application of neuroscience to education.

Chapter 2: LITERATURE REVIEW

Introduction

This literature review looks at neuroscience discoveries which have some relevance to the field of education and subsequently may have an impact on teaching practice. Traditionally discussion between educators and neuroscientists has been limited by each field's understanding of the context in which they work. In many cases translating neuroscience findings to useable classroom practices is not a direct or simple task. Neuroscience research has the potential to change the way that educators 'do business.' As the debate about translation from research to practice continues, communities of educators and neuroscientists agree that collaborative research will assist both fields to appreciate the other and assist in the development of a common language and shared understanding.

Crossing boundaries to inform a new field of study

Neuroscience is the neurological study of the workings of the brain. This science is able to use functional Magnetic Resonance Imaging (fMRI) and Electroencephalography (EEG) technologies to map the significant electrical circuitry of the brain. Some educators are attempting to link the neurological discoveries of neuroscientists to their pedagogical practices (Chudler & Konrady, 2006; Diamant-Cohen, Riordan, & Wade, 2004; Jensen, 1998; Summak, et al., 2010). There is however, a disconnect between neuroscience findings and their application to an educational setting (Bruer, 1997; Geake, 2004, 2008)

Many researchers including Willingham (2007), Haier and Jung (2008), Perkins (2009), and Purdy and Morrison (2009) maintain there are limited direct links between education and neuroscience discoveries. Yet some educators and neuroscientists understand the

promise of new and scientifically supported practices for education and attempt to make links between the two disciplines. Researchers working across conceptual boundaries between education and neuroscience describe their fieldwork by various terms including: neuroscience, psychology, cognitive science, cognitive neuroscience, educational psychology, educational neuropsychology and educational neuroscience.

Akkerman and Bakker (2011) propose that there remains a natural boundary between these two fields. The range of terms used to describe the merged field between education and neuroscience also indicates the range of expertise that is required to make such connections. Engestrom, Engestrom and Karkkainen (1995) proposed the term 'boundary crossing' to describe the process of merging different contexts to achieve hybrid situations. In order to connect education and neuroscience for the purposes of developing changes to classroom practice, researchers collaborating within these fields have attempted multiple boundary crossings in order to apply current discoveries to educational contexts.

Boundary crossing involves four different levels of learning: identification; coordination, reflection and transformation (Akkerman & Bakker, 2011). These levels are evident in the boundary crossing that educators and neuroscientists are engaged with. These efforts have been identified by educators (Goswami & Szűcs, 2011; Howard-Jones, Winfield, & Crimmins, 2008; Perkins, 2009; Summak, et al., 2010; Willingham & Lloyd, 2007); discoveries have been coordinated and reported, (Kalbfleisch, 2008; Purdy & Morrison, 2009; Summak, et al., 2010), reflection on practice is evident in the collaboration between education and neuroscience (Christodoulou & Gaab, 2009; Varma & Schwartz, 2008) and transformation has been applied in educational contexts (Howard-Jones, et al., 2008; Purdy & Morrison, 2009; Willingham & Lloyd, 2007).

The research which evidences these four levels of learning however report varying degrees of success in the boundary crossing between education and neuroscience.

Commonly, this is expressed by researchers as a degree of disconnect best described as a difference of interpretation across the fields of education and neuroscience (Akkerman & Bakker, 2011).

Some differences of interpretation

Researchers provide various reasons for the disconnection between education and neuroscientific discoveries. Many of these reasons are directly related to the need for a shared perspective of the opposing field. Goswami (2009), Murphy and Benton (2010), Tommerdahl (2010) and Goswami and Szucs (2011), contend there is a need for neuroscientists to develop a better understanding of the educational context and what educators actually do in their classrooms. Neuroscience researchers observe teachers applying discoveries without fully understanding the science context. Traditionally teacher practice has more readily utilised the more familiar concepts of educational psychology, such as the proposition of left and right brain learning (Sperry, 1983) Geake (2004, 2008) proposes that teaching focuses upon the behavioural level of practice, whereas neuroscience focuses specifically on brain response and stimulus. Consequently, researchers of neuroscience perceive educators to be misusing neuroscience when they implement brain based strategies without fully understanding the research underpinning the neuroscience.

Amongst those supporting a collaborative approach are researchers already conducting shared research in the field. Each has articulated varying degrees of disconnect between the fields of education and neuroscience related to the following areas: no shared common language (Levine & Barringer, 2008; Purdy & Morrison, 2009; Summak, et al., 2010); limited teacher perspective (Geake & Cooper, 2003; Mason, 2009; Murphy & Benton, 2010; Tommerdahl, 2010); misunderstanding of the role and context of the teacher (Christodoulou & Gaab, 2009; Geake, 2008; Goswami & Szűcs, 2011; Purdy & Morrison, 2009); and teachers' early adoption of neuroscience findings without fully understanding the limitations of the research findings (Alferink & Farmer-Dougan, 2010;

Christodoulou & Gaab, 2009; Geake, 2004; Goswami, 2009; Jacobson, 2000; Miller & Tallal, 2006; Purdy, 2008; Waterhouse, 2006a, 2006b).

During the past decade more researchers have proposed that greater collaboration between the education and neuroscience fields would provide insight for all researchers about the alternate field (Carew & Magsamen, 2010; Christodoulou & Gaab, 2009; Coch & Ansari, 2009; Szűcs & Goswami, 2007; Tommerdahl, 2010). To this end a number of joint studies have been conducted during this time. The range of research conducted is broad and includes: special education support (Alferink & Farmer-Dougan, 2010); auditory visual connectivity of infants (Goswami & Szűcs, 2011); the difference between thinking and neural activity or cognition and brain function (Purdy & Morrison, 2009; Varma & Schwartz, 2008); gender differences of the brain (Haier & Jung, 2008); creativity (Howard-Jones, et al., 2008); mathematical reasoning as a network process (Varma & Schwartz, 2008); and mental representations (Szűcs & Goswami, 2007). These varied studies are indicative of the complexity of the field that is currently occupying researchers.

Neuroscience discoveries

Neuroscientists have made some discoveries that can be applied to teaching practice and believe that many more useful discoveries will be made in the near future. The following section reviews some information that neuroscientists have uncovered.

Neuroscience studies determine what is proven

Discoveries that are transferable or useful to educators include those regarding brain wiring and plasticity. Many studies support the premise that there is a plasticity of synaptic connections in the brain that confirm wiring and rewiring can occur throughout life as there is not a fixed intelligence as previously contended (Geake, 2008; Purdy, 2008; Szűcs & Goswami, 2007; Varma & Schwartz, 2008). There are periods of high

synaptic growth and pruning, although these periods of growth do not correlate with learning retention or memory loss (Bruer, 1993) as previously believed.

Other research has provided clear neuroscientific descriptions about brain structure and brain function (Geake, 2008; Goswami & Szűcs, 2011; Haier & Jung, 2008) and has been able to make correlations between the two. Goswami (2009) has already identified some biomarkers for educational risk in literacy. Biomarkers are molecules that detect and isolate specific functional areas of the brain. Goswami (2009) has been able to isolate various regions of the brain connected to the learning of literacy.

Yet other research indicates it is most likely the brain functions by using a network focus (Szűcs & Goswami, 2007; Varma & Schwartz, 2008); not as activity on a single side of the brain as suggested in early studies of the left and right brain functions (Sperry, 1983). Neuroscientists show that brain function can be identified across brain hemispheres.

Research has also found that the strength of synaptic connections (Freeberg, 2006; Garrett, 2008) is more indicative of a heightened ability to use one's existing neural network. Similar research in this area has found it is not important to experience an enriched environment to enhance neural development, however, a deprived environment will not enhance neural development (Purdy, 2008).

An auditory and visual connection to learning has been identified. The senses of hearing and sight working in tandem for effective learning (Calvert, 2000; Goswami, 2009; James, 2007). This confirms practices that have been used in schools for many years where educators provide activities with the incorporation of auditory and visual input.

Discoveries regarding gender differences in male and female brains were initially determined during studies of mathematical reasoning (Haier & Benbow, 1995) and since this time have been confirmed in several studies of intelligence with adults and children (Haier, Jung, Yeo, Head, & Alkire, 2005; Jung & Levine, 2005; Schmithorst, 2006; Yurgelun-Todd, 2002). This research has provided evidence which concluded that not all brains function in the same way.

Neuroimaging has provided visual confirmation of the way the brain functions and confirms what educators already know (Mason, 2009). For instance, cognitive organisers and thinking strategies are useful learning tools (Varma & Schwartz, 2008; Waterhouse, 2006b). Educators have used cognitive organisers and thinking strategies as part of best practice since curriculum documents were produced endorsing the explicit teaching of critical and creative thinking skills in the 1970s.

Neuroscience discoveries support curriculum variety, teaching problem solving skills, working in cooperative groups and using rote or repetitive practices, each is confirmed as a sound educational practice (Waterhouse, 2006a). Emotion, decision making and social functioning are also found to be connected (Immordino-Yang M.H., 2007) to effective learning by neuroscience research. Each of these teaching considerations and practices are readily adopted when planning classroom experiences for students.

Neuroscience and 'Neuromyths'

Geake (2004), Purdy (2008) and Waterhouse (2006b) propose that teachers have adopted naive theories of reported brain research for classroom use which are not informed by neuroscientific evidence. They maintain that whilst neuroscientific research is revolutionary regarding a developing understanding of how the brain works, it is not yet readily transferable to an educational context. Neuroscientists have used the term 'Neuromyths' to describe the naive adoption of these theories when used in educational settings.

Waterhouse (2006a) contends that common neuromyths such as Gardner's Multiple Intelligences (Gardner, 1983), the Mozart Effect (Rauscher, 1993) and the premise of Emotional Intelligence (Salovey, 1990; Waterhouse, 2006a) lack empirical support for neuroscientific credibility.

Gardner's Multiple Intelligences (1983) was originally proposed to encourage teachers to consider individual student strengths and interests and to teach to these strengths. However, there are no published studies of psychometric testing that might offer empirical evidence for the validity of the Multiple Intelligences model.

When investigating the Mozart Effect, Waterhouse (2006) found evidence for excitation and reward affecting memory retention but no empirical support for the use of music to enhance brain function. It is suggested that the source of the Mozart Effect may in fact be cortical arousal as revealed by Husain, Thompson, and Schellenberg (2002) and Thompson, Schellenberg, & Husain (2001), although this link has yet to be validated.

Emotional Intelligence (EI) theory was popularised by Goleman in 1995, who proposed emotional intelligence was connected to brain wiring and had a more profound effect upon student learning and achievement than academic intelligence. Waterhouse maintains that 18 of 21 job competencies proposed by Goleman (1995) as Emotional Intelligence indicators could not be differentiated from five basic personality constructs (Matthews, 2005) thereby, having no brain based foundation for neuroscientific credibility. Those constructs included warmth, conscientiousness, sociability, neuroticism and openness (Matthews, 2005; Paris, 2005).

Other researchers are critical of the educational use of frameworks such as left and right brain learning preferences (Sperry, 1983). Original left and right brain function studies were conducted on animal and human subjects that had suffered separation of the corpus callosum, thereby restricting the cross over brain functions that apply in normal subjects. These findings were made from deficit studies and thus provide limited useful knowledge in relation to normal brain functioning (Benton, 2010; Carew & Magsamen, 2010; Christodoulou & Gaab, 2009; Geake, 2004; Goswami, 2009; Purdy, 2008).

The Auditory Visual and Kinesthetic model (Dunn, 1984), has also been criticised by neuroscientists (Geake, 2008; Purdy, 2008) who argue teachers are using the Auditory, Visual and Kinesthetic preferences of their students to provide learning experiences which are limited, rather than enhanced, by these preferences. There are examples of schools and

teachers whom have labelled students by learning preference using labels of A, V or K on the students shirts for easy identification (Purdy, 2008). Scientists maintain that focusing on one sensory modality is in direct contradiction with research which has identified the interconnectivity of the brain (Geake, 2008). Coffield et al. (2004) found that modifying a teaching approach that would cater for learning style preferences does not necessarily result in any improvement in learning outcomes.

Brain Gym techniques (Dennison, 1988) are criticised as moving beyond the findings of neuroscience in the transfer from laboratory to classroom (Howard-Jones, 2008). Blakemore and Frith (2005) suggest general exercise has been found to be supportive of brain function but are they critical of the Brain Gym premise that specific exercises connect left and right brain functioning if used before learning or assessment tasks.

Practices and variations from all these models are currently widespread and are used in many classrooms throughout the education world. Howard-Jones (2007) suggests "this is not to say there is not a glimmer of truth embedded within various neuromyths. Usually their origins do lie in valid scientific research; it is just that the extrapolations go well beyond the data" (p.124).

Neuroscience and implementation in the classroom

In attempting to translate neuroscience discoveries to classroom pedagogy, some educators and neuroscientists are finding that current discoveries are not readily applicable to classroom contexts (Bruer, 1997; Perkins, 2009; Purdy & Morrison, 2009; Willingham & Lloyd, 2007). For instance, Szucs and Goswami (2007) believe that the translation of neuroscience findings to classroom practice is limited and that neuroscience should focus upon basic science to produce quality outcomes. The challenge of integrating findings to educator contexts highlights the limitations of neuroscience data collection methods such as EEG and fMRIs. These instruments are not capable of capturing the intricacies of classroom learning by simply correlating brain activity with behaviours, nor can these measures conclusively state that brain activity actually indicates

problem solving. There are high expectations of application from neuroscience to education but at this stage there are very few findings that are practically useful to educators (Ansari & Coch, 2006).

Researchers cite direct transferability issues as the main cause for their limited enthusiasm for usage in school classrooms. Bruer (1997) a highly regarded and much cited researcher in the field of neuroscience application to teaching contexts considered the connection between education and neuroscience to be 'a bridge too far'. Although opinion has somewhat changed since this statement, several researchers are providing only qualified support for the translation of current neuroscience to classroom contexts (Perkins, 2009; Purdy, 2008; Willingham & Lloyd, 2007).

Much consternation revolves around the premise that the theory of learning used by educators operates at a completely different level to the brain learning theory used by neuroscientists. Willingham (2007) suggests that whereas neuroscience measures brain function under controlled experimental conditions, education has competing systems that include classroom interactions, and school and wider community influences, which cannot be accurately measured in the same context as scientific research.

Educators are seeking clarity regarding transferability of discoveries, whilst neuroscientists openly criticise the use of commonly adopted teaching practices for student differentiation such as MI, AVK or other learning style frameworks (Geake, 2004; Goswami, 2009; Purdy, 2008; Waterhouse, 2006b). Currently it appears there are limited findings that might provide options to replace these common practices (Bruer, 1997; Perkins, 2009; Purdy & Morrison, 2009).

Acknowledging difference of purpose

The range of opinion regarding useful connectivity between neuroscience discoveries and education is extensive. This range of opinion appears in the literature as a dilemma of understanding the widely varied expectations of the education and neuroscience communities for each other. Perkins (2009) proposes much of the variance in understanding the other field is found in the theories that educators and neuroscientists

use. He suggests that educators and neuroscientists use opposing theories. Neuroscientists commonly use explanation theories for their work, whereas educators use action theories. Explanation theory refers to the thinking and learning the brain does, and is a theory developed by neuroscientists. Action theory describes how to get something done and is a test of practical efficacy, a theory often used by educators. The field of educational neuroscience therefore comprises educators and neuroscientists who are asking different questions and looking for different answers.

In order to use neuroscience explanation theory in teachers practical (action) contexts, explanation theory will need to be translated to some extent into action theory. For example, the neuroscience discovery that strong synaptic connections indicates a brain is working more efficiently currently has limited application to educators. Until this explanation can be translated into action theory such as through what activities teachers can provide to encourage the development of strong synaptic connections, there will be continue to be a gap in both understanding and implementation of valid neuroscience discoveries into relevant teaching practices.

The range of opinions

Beyond the debate of difference in purpose exists other considerations when considering transferring neuroscience discoveries to the educational context. There are researchers that propose neuroscience should control the teaching agenda (Benton, 2010) and/or that neuroscience should be the primary reference source for all teaching practice (Kalbfleisch, 2008). Some other researchers maintain neuroscience findings should be limited to direct instructional experiences, informing pedagogy but not curriculum (Christodoulou & Gaab, 2009; Geake, 2008) and be limited to remediation and special needs (Varma & Schwartz, 2008). Yet other researchers maintain neuroscience findings are already a useful source for educators but should be considered alongside other methodologies (Coch, Michlovitz, Ansari, & Baird, 2009; Mason, 2009; Murphy & Benton, 2010; Tommerdahl, 2010).

Some researchers can demonstrate that neuroscience findings are already working in educational contexts, such as in the teaching of creativity (Howard-Jones et al., 2007). Levine and Barringer (2008) provide another example of early program adoption in a Special Education context, their study looks at how neuroscience is able to assist educators by identifying struggling learners and recommending the use of explicit teaching to treat these students.

At times, educators are misusing connections from neuroscience to education. One example of educators linking neuroscience information to pedagogical practices (Diamant-Cohen, et al., 2004; Howard-Jones, 2007) involves a group of library teaching staff who attended a brain based conference and transposed their enthusiasm for the information shared at the conference to classroom practices in the library, believing them to be neuroscience based. The teacher librarian's adoption of MI, learning styles and Brain Gym into lessons has extrapolated the neuroscientific findings beyond the level of neuroscience application (Diamant-Cohen, et al., 2004).

Purdy (2008) also shares the Northern Ireland curricular reform as an example of teacher enthusiasm gone too far. In Northern Ireland the newest curricular reform of 2007 included endorsing the use of teaching practices that considered Left and Right brain theory; acknowledging and planning funding and resource allocation around critical periods of synaptic development; implementing AVK models; and the use of Brain Gym activity into the national curriculum. Teachers across Northern Ireland are implementing these neuromyths in their classroom practices, yet each of these theories has been disproven from a neuroscience perspective (Geake, 2004; Purdy, 2008; Waterhouse, 2006a).

Collaboration for mutual benefit

There is hesitation amongst many neuroscientists to share their research with educators because of the prior adoption of neuromyths, however there is also a realisation amongst educators and neuroscientists that the different expectations between educators and neuroscientists cannot be addressed without a shared language and understanding of the

other field. Researchers from both education and neuroscience insist that appropriate professional development for teachers is of the utmost importance (Carew & Magsamen, 2010; Coch & Ansari, 2009; Purdy & Morrison, 2009). They add that tertiary institutions must include neuroscientific facts in undergraduate education training programs to further address this issue (Ansari & Coch, 2006; Geake & Cooper, 2003; Howard-Jones, et al., 2008; Murphy & Benton, 2010; Twardosz, 2007).

For educators to determine the implications of neuroscience discoveries they need to understand the language and some of the important and relevant concepts to their field. Connecting educators and scientists can assist with this process (Purdy & Morrison, 2009). When educators are critical consumers of neuroscience facts they are better able to determine what applications these findings have for their pedagogical practices. This would enable educators to make informed decisions regarding the use of brain based practices in classroom contexts (Coch & Ansari, 2009; Geake & Cooper, 2003; Hall, 2005) and in the process be able to determine fact from fiction.

In 2004 the *Open Education Community Development* (OECD) and Harvard Graduate School jointly held a conference for educators. This was an early attempt to connect research and practice for the benefit of both educators and neuroscientists. It was hoped that opportunities to develop an appreciation of the opposing field would assist in providing a degree of translation to each context. Educators learned about the purity of experimental research in the neuroscience field and neuroscientists developed some insight into the complicated and complex role of the educator.

Harvard Graduate School of Education now provides a 12 month post graduate course entitled *Cognitive Development, Education and the Brain* and similar graduate programs are also being offered at John Hopkins University, Vanderbilt University and Nashville University of Texas and more (Summak, et al., 2010). There are also study and discussion groups currently being established in the United States and the United Kingdom; The International Mind, Brain, and Education Society and the Neurosciences and Education Science Interest Group of the American Educational Research Association (AERA) are examples of this increasing interest (Blake & Gardner, 2007).

Study and training incorporated into undergraduate courses is recommended as an ideal way to affect development of a common language and shared understanding between scientists and educators. To provide training within the university system creates an important opportunity to enhance the discipline area knowledge of the next generation of teachers. Study and training options are proposed and supported by many current researchers (Ansari & Coch, 2006; Geake & Cooper, 2003; Howard-Jones, et al., 2008; Murphy & Benton, 2010; Twardosz, 2007).

Conclusion

Much research has been conducted from a neuroscience perspective to unpack the workings of the brain. It is vital that educators' reading and use of research based neuroscientific knowledge is informed and appropriate for their classroom practice *** (Geake, 2008; Goswami & Szűcs, 2011; R. J. Haier & Jung, 2008; Howard-Jones, et al., 2008; Kalbfleisch, 2008; Murphy & Benton, 2010; Summak, et al., 2010; Tommerdahl, 2010; Varma & Schwartz, 2008; Willingham & Lloyd, 2007). Collaborative research across neuroscientific and educational fields will provide further opportunity to develop contextual awareness of the education environment and develop future research that has direct relevance to educators.

Collaborative research can assist educators to develop an appreciation of the work and limitations of neuroscience. Sharing research can also provide an insight for neuroscientists into the intricacies of the role of the educator. Both fields agree that developing a common language and shared understanding are long overdue. Strategies to assist this process include professional development for teachers through field visits, conferences and continuing education but there is also an opportunity to train future teachers whilst they are studying in undergraduate courses.

Undergraduate training is vital in the education of our next generation of teachers so that they may adopt research based practices in their classrooms and education contexts,

understanding the impact of sound research and evaluating common classroom practices that have limited scientific proof. Neuroscientists also need to be invited to be part of this professional development for teachers in order to provide accuracy and accessibility to relevant research. Direct contact between educators and neuroscientists will assist to develop an understanding of the other's role and research in seeking knowledge about the way the brain functions.

Some researchers propose neuroscience will best assist teachers by focusing upon the application to students with specific learning disorders such as dyslexia, dyspraxia or students with special needs requiring a focus on direct instruction (Christodoulou & Gaab, 2009) or remediation (Varma & Schwartz, 2008). Other researchers propose neuroscience can be the basis of all education practices (Benton, 2010) or the primary source of information regarding teaching practice (Kalbfleisch, 2008). Benton (2010) and Kalbfleisch (2008) propose that neuroscience discoveries should be used to determine the teaching practices and structured activities that are provided for students to learn.

Only when neuroscience researchers and educators work together to share their contextual knowledge will the 'bridge' referred to by Bruer (1997) allow useful application of this research to occur in the classroom settings.

Chapter 3: METHODOLOGY

Introduction

This chapter looks closely at the case study approach which has been selected for the research. Consideration is given to the purpose of the study and provides the overarching questions and delimitations of the inquiry. The chapter details the process for the selection of participants and confidentiality concerns that guide the investigation. The researcher's background pertinent to the study is available for scrutiny and specific methods and techniques determined useful for the study are shared and defended. Data analysis is described and supporting documentation is provided within the appendices. Consideration is given to the reliability and validity of interpretations in relation to pertinent literature.

Purpose of the study

The purpose of this study was to examine and understand the influences that university coursework has upon the selection of the teaching approaches and pedagogy of first year teachers, to investigate to what extent it has been influenced by situational context and to utilize the data to inform future initiatives designed to articulate the findings of neuroscience, where relevant, to classroom teaching and the broader field of education.

The study aimed to collect evidence of current pedagogical practices from first year graduate teachers and review these practices in order to ascertain if previous university coursework related to neuroscience considerations were incorporated in their teaching approaches and practices. The two main research questions which guided the study were:

- How are first year teachers' teaching practice decisions influenced by their prior university learning and their current school context?
- To what extent, if any, do first year teachers incorporate and implement neuroscience supported practices in their teaching program?

Delimitations

The following delimitations are presented to provide the reader with an overview of the scope of the study.

- This study was conducted inside a data collection timeframe of 10 weeks during which time two rounds of interviews were conducted. These time limitations meant data collection was conducted within a single school term thus providing data specific to Term Three content and resultant pedagogical practices.
- The first year graduate teachers in this study have limited experience upon which to draw knowledge and practice as they have had a maximum of two school terms to learn systemic and local school based protocols.
- Student behaviour directly impacts the choices of pedagogy used by educators. Poor behavior limits the options available to educators who are required to manage classroom behaviour in order to maximise learning experiences.
- This study was designed to observe the phenomenon under investigation, not to evaluate school and systemic based practices.
- It is understood that schools and systems will have preferences for teaching practices that to some extent will impact upon the educators' choice of content and pedagogical approaches and practices.
- Practices employed in classrooms are also heavily influenced by educator's personal preferences. It was not the intention of this study to make value judgments regarding the decisions first year graduate teachers made for their classroom but to investigate what and how these decisions are made.
- The university course work, that has become a focus of this study, was not provided initially with the intention of measuring application in classroom settings, but to support sound teaching practice.
- Definitions and descriptions of similar pedagogy varied across participants in their settings, eg. Constructivist learning was on various occasions described as hands on, use of manipulatives, group work, activity based, discovery learning and practical activities. These descriptors were collated under a similar heading.

Case Study Methodology

There are three conditions that made case study methodology ideal for the focus of this study. As Yin (2003) notes, the type of research question posed, the extent of control the researcher has over the actual events and the degree of focus on contemporary versus historical events are all important elements of a case study. Under each of these categories the proposed project has met these conditions. Firstly, the research questions posed are of the 'what, why and how' nature characterized in case study methodology (Yin, 1994). Secondly, the researcher has very limited control over the actual events that occur during the research period. Thirdly, the actual research is very contemporary. There remain limited neuroscience pedagogy studies conducted in school contexts and no search has been found that has tracked epistemological knowledge from a university learning context to a teacher practitioner context with this particular focus.

The case study approach has the advantage of being both flexible and adaptive. Case studies can be developed to suit the specific context of the study. Many different ways of gathering data are appropriate, including but not limited to; documentation, archival records, interviews, direct observations, participant observation and artefacts (Yin, 2003). Researchers may select collection methods most appropriate to the specific context thus allowing a high degree of flexibility and adaptivity in the design of the study. Flexibility and adaptivity were highly considered during the selection process as they were necessary to meet research design requirements for data gathering in the classroom contexts. Alternatives were investigated regarding the collection of data after separating phenomenon and context; however this was not considered to yield the richness of information required to inform the project.

A case study offers the researcher an opportunity to produce a rich 'thick' description of the phenomenon. 'Thick' is a term used to describe the rich level of information provided for the benefit of the study. Use of the regular classroom environment provided authenticity to the case study. Other methodologies often rely upon more controlled or artificial environments inside which the investigation is conducted. The opportunity to analyse an everyday situation and subsequently provide a 'thick' description of the

investigation became compelling as it afforded the researcher the opportunity to explain the findings using rich sources of information including the participants' personal backgrounds and current teaching school contexts (Lamnek, 1995). It was highly likely that participants' personal histories would influence their teaching practice and subsequently the findings of the study. If each person was considered to develop their knowledge in context, then the aim of the research was to understand the influences that affected the educators' selection of teaching practices.

A descriptive case study was chosen for its ability to provide a 'thick' description of the phenomenon under investigation. This rich detail provides important detail to enable connections to be made between neuroscientists with limited background in education as well as to provide educators with nil or limited background in neuroscience to see the potential of working together to utilize scientific findings in classroom contexts. Merriam (1998) has suggested that a descriptive case study is best used to chronicle events where little research has been conducted previously, this interpretation complements this study as limited additional research exists.

Yin (1993) proposes three main types of case study: exploratory, explanatory and descriptive. The researcher has utilized a descriptive case study model for several reasons. Firstly, it provides an illustration of the complexities of the education contexts under investigation and provides an opportunity to incorporate how personal background may influence the issue under investigation. Secondly, descriptive case study may also demonstrate how situational context can influence the implementation of pedagogy for a first year graduate teacher.

The descriptive case study is also designed to reveal a chain of evidence (Corcoran, 2004) and provide a complete description of the phenomenon. Yin (1984, 1989), states the descriptive case study covers both scope and depth through the gathering of multiple sources of evidence. There is therefore an obvious chain of evidence with data being managed through pattern matching and explanation building. This technique has been employed to analyze the data and findings and is further detailed in the data analysis section below.

Criticisms of the case study model (Simons, 1996; Kyburz-Graber, 2004) include its focus on singular contexts and/or lack of quality criteria. This project has addressed each of these criticisms in the design of the research. Multiple sources of evidence have been used to develop the validity of the data and the method of pattern matching has supported the relevance of criteria across sources of evidence. Both Simons (1996) and Kyburz-Graber (2004) endorse these approaches to minimise disjunction within the case study methodology.

The Participants

This section details the process used for recruitment of the participants and consideration of ethical and confidentiality issues, including details of voluntary withdrawal from the study if requested.

Recruitment of Participants

An email invitation was distributed to all students at USQ Springfield Campus graduating from their four year Bachelor of Education (BEDU) program at the completion of 2010. There were 74 graduates of the program at this time. A sample size of six was considered large enough to yield sound data for the purpose of this research. Seven students from the population of 74 volunteered for the research project. Each of these volunteers was selected for the study. One student has since withdrawn due to illness. This sample size provided extensive opportunity for comparison of data and the resultant thematic analysis.

The current school contexts of the six participants revealed a cross section of Early Childhood and Primary appointments in small (60 students) and large (900 + students) schools, ranging from high percentage Aboriginal and Torres Strait Islander (ATSI) or English as a Second Language student (ESL) schools to mono-cultural schools, with low to high socioeconomic status, and country and city schools including public and independent sectors. Volunteers included five female teachers (83.4%) and one male teacher (16.6%). The general Early Childhood or Primary teaching population in

Queensland schools is currently in the vicinity of 80% female, 20% male (personal communication, Ken Suthers, EQ Human Resources Officer, Central Office, Brisbane, August, 2010). Thus, this percentage provided a cross section basically reflective of the general primary school state education teaching population statistics.

Ethical Issues

Confidentiality of data provided by participants is paramount. Every effort has been made to manage the confidential collection and interpretation of data. Pseudonyms have been used for the participants to de-identify all data. All interviews have been digitally recorded and transcribed in full. These are stored safely in a locked filing cabinet and on a password protected computer. All identifying evidence has been removed from these records. Hardcopy photographs and personal philosophical statements have been treated with the same level of care and confidentiality.

Ethical clearance from University of Southern Queensland's Ethics Committee was sought and granted under Higher Research Ethical Clearance Approval Number: H11REA095. A request for amendment to include classroom photographs (without students) and personal philosophical statements was also granted under the following approval number: H11REA095.1. (See Appendix 1).

Withdrawal of Consent

Participation in the project was entirely voluntary. Participants of the USQ *EDP4000: The Beginning Professional* were not obliged to be involved. When volunteers made their decision to take part they were advised that there was no obligation if they later changed their mind. The invitation to participate included information stating they were free to withdraw from the project at any stage and any information previously obtained would be destroyed. Potential participants were also advised there would be no stigma or

repercussions which would affect their relationship with the University of Southern Queensland or the researcher if they decided to withdraw.

The Role of the Researcher

It is important to consider the role of the researcher in any study and the potential to bias how the findings are presented. Therefore, due consideration has been made in relation to the influence of the researcher upon the data gathered. The background experience of the researcher has been shared in the following section to provide further insights into their professional interests.

Reflexivity

Findlay (2002) proposes reflexivity to be a defining feature of qualitative research, whereby researchers consider co-construction of knowledge with their participants. Researchers must make explicit their experiences that may impact the trustworthiness, transparency or accountability of data collection (Findlay 2002).

In gathering the data for this case study, the researcher needs to acknowledge the extended rapport developed with the participants in a lecturer – student relationship. A level of trust was developed during university years that allowed a trusted and privileged insight was shared of the day to day teaching demands and choices that each beginning teacher made regarding content or pedagogy choices as well as daily administrative expectations of classroom management and behaviour management. This is both a benefit and a difficulty. The benefit manifests as honest and open data provision through interviews and personal philosophical statements. Difficulties arise if the researcher is not mindful of this connection and familiarity. However, the opportunity to objectively gather the rich data provided for research purposes is gratefully acknowledged. Consideration of this privileged situation was enabled when contextualising responses and coding and

categorising data. This empathetic approach to participants should also be highly considered for the research opportunity this presents.

> *Qualitative research depends to a great extent on the interpersonal skills of the inquirer, such as building trust, keeping good relations, being non-judgemental, and respecting the norms of the situation. Researchers use all their personal experiences and abilities of engagement, balancing the analytical and creative through empathetic understanding and profound respect for participants' perspectives. Interpersonal emotions in field work are essential in data collection activities because of the face-to-face interaction (p. 327).* McMillan & Schumacher (2006)

This case study acknowledges the researcher and participant backgrounds and strives to allow each to represent an authentic self in the research as this is shared.

The Researcher

As a researcher it was important to describe my own more complete background and acknowledge how my biases, values and interests can affect the research. This sensitivity to personal biography, known as reflexivity, acknowledges that all research is laden with values (Creswell, 2003).

The researcher is a lecturer at the University of Southern Queensland (USQ), Springfield Campus and provided lectures, tutorials and workshops for the EDP4000 student group in Semester 2, 2010. This was the final semester of study for the student group and included their internship (final and unsupervised block teaching practice) and completing applications and interviews for public and private schools for employment. The 74 students were mentored and supported throughout this process by the lecturer. Students valued the previous school based experiences of the lecturer and sought advice on many aspects of their developing awareness as graduating educators. A focused approach and genuine concern for students and their queries developed over the course of the semester and a level of trust was established between the lecturer and the students, particularly given the importance of this subject to their future teaching career.

The educational experience of the researcher include 30 years teaching across many Australian schools which finally culminated in the role of Principal at an elite Brisbane Primary School. In this role the researcher convened many graduate and teacher application panels and mentored new teachers in their early career school appointments.

The researcher admits high level interest in achieving good outcomes for the tertiary pre-service teachers in her care and the opportunity to impact their future teaching approaches to primary and secondary students. Developing effective educational pedagogy has always been of high personal interest to the researcher and providing continuing professional development for teaching staff has consistently been a career focus. It is acknowledged that these personal priorities need to be considered in the context of the research being conducted to remove bias and values from the data gathering and analysis processes.

Also acknowledged at this time is the researcher's experience and expertise which subsequently was used to interpret the data gathering in the school context. This was advantageous to the study as the researcher was more fully able to understand and interpret the influences and nuances of school and systemic expectations and empathise with the constraints of classroom and behavior management issues experienced by the graduate teachers. This background knowledge was pivotal in analyzing and providing important insights in relation to the data.

The case study methods & techniques

Data was collected for the research using the following qualitative instruments; two individual semi structured interviews per participant and the two artefacts including; classroom photographs and graduate philosophical statements. The photographs were taken of classroom seating and layout, resources, displays and student work samples in the first three weeks after Round One Interviews. The philosophical statements were written by the first year graduate teachers for their portfolios whilst completing their final semester of university study.

Procedure

Upon completion of the email invitation to participate process, participants read the information sheets and signed the consent forms (See Appendix 2). They were then informed of the timeline for the interviews and the artefacts which would be required to prompt further discussion during the interviews. The interview and data collection schedule appears in Figure 1 below.

Round 1 Interviews	Time	
Tues 14 June 2011	11.00am	Participant 5
Wed 15 June 2011	4.00pm	Participant 4
Tues 21 June 2011	9.00am	Participant 1
Tues 21 June 2011	11.00am	Participant 3
Wed 22 June 2011	4.00pm	Participant 6
Wed 22 June 2011	5.00pm	Participant 2
Thurs 23 June 2011	10.00am	Participant 7

Friday 1 July 2011	Photographs requested
	Personal philosophical statements requested

Round 2 Interviews	Time	
Mon 29 August 2011	11.15am	Participant 6
Mon 29 August 2011	3.30pm	Participant 4
Tues 30 August 2011	5.00pm	Participant 1
Wed 31 August 2011	11.15am	Cancelled Participant 7
Wed 31 August 2011	3.30pm	Participant 3
Thurs 1 September 2011	3.30pm	Participant 5
Wed 7 September 2011	4.00pm	Participant 2

Figure 1. Interview and data collection schedule

Data Gathering

The semi structured interviews were designed to enable the participants to provide relevant information in relation to the two research questions. Both sets of interviews were designed to last between 25 - 30 minutes. The purpose of the Round One Interview questions (See Appendix 3) was to develop an understanding of the teacher's context and regular routine, the impact of systemic expectations, influences upon their time to develop professionally and their implementation and articulation of prior education training knowledge to their current teaching context. The semi-structured nature of the interview questions provided the researcher with a standard format to follow but also provided flexibility to pose additional questions if answers given required further detail or assisted the line of research.

The Round Two Interviews (See Appendix 3) were designed to corroborate the previous interview information and detail any changes that may have been enacted in the interim between interviews. During the interviews the researcher sought additional understanding or articulation of the research focus, investigating relevant issues raised in the Round One Interviews. Photographs and Philosophical Statements were requested of participants after the Round One Interviews and these were used prior to the Round Two Interviews for corroboration of interview data then again as artefact elicited prompts in Round Two Interviews. The photographs and personal philosophical statements were used to request clarification of meaning, encourage the expansion of responses and confirm participants' verbal responses, where relevant. Used in this manner the photographs and personal philosophical statements provided additional qualitative data for the project.

The inclusion of these artefacts also provided additional evidence to support or deny the correlation of data. Participants understood the photographs would be used as artefact elicited prompts during their second interview and corroborate information provided during Round Two interviews. This enabled further triangulation and verification of other

data sources. The personal philosophy statements were considered useful data, as prior to graduation these philosophies reflected the teachers aspirations for being a great teacher, unaffected by later school or systemic expectations.

Implementation of Interviews

Interviews were conducted either in person or as telephone interviews. All interviews were digitally recorded. Each participant was able to select the mode most accessible for them but in four out of six cases the first interview was held in person and the second by telephone. One participant chose to participate in both interviews by phone. On each occasion, prior to recording the research interview the lecturer spent a few minutes with each participant discussing how their first teaching appointment was progressing and what changes they were experiencing in their daily lives as first year teachers.

Recording the Interviews

Digital audio recordings were made of each interview. The recordings were downloaded and stored in a file on a password protected computer. These recordings were transcribed in order to ensure accuracy of the data and transcriptions were stored on a password protected computer. They will be destroyed at the end of the required five year period from date of transfer.

Data Analysis

Yin (1984, 1989) describes the analysis of data as pattern matching to build explanation. Pattern matching and explanation building techniques were used to analyse the data in this case study. Pattern matching requires repeated comparisons across data sources to determine patterns. This allows the researcher to identify stronger validity. Explanation building is a technique adopted to connect causal links to the phenomenon being

observed. It is important in completing this data analysis that all evidence is attended to in the process and that consideration is given to possible rival explanations.

For the purposes of this project, a search for themes within each interview transcript was conducted prior to a similar search for themes between the first and second transcripts for each participant. Further levels of analysis include searches for themes across interviewees at the culmination of Round 1 Interviews and repeated after Round Two Interviews. Miles and Huberman (1994) suggest early analysis may involve placing information into arrays or matrices and tabulating frequencies of occurrence. These collation techniques were adopted to categorise the data. An analysis of the classroom pedagogy and practices articulated by each participant during Round One Interviews was collated into one or more of the three targeted categories; systemic and school expectations, university coursework or coursework of neuroscience application. This process was repeated for Round Two Interviews and was graphically displayed in tabular form (Miles, 1984). Round Two Interviews provided the opportunity for teachers to verify earlier information or articulate changes to their practice. Additional questions were asked to gather detail from photographs and personal statements. Another level of pattern matching was conducted comparing participants once again using arrays and matrices to collect and interpret the data.

Analysis of data began by listing all pedagogical practices mentioned at interview. Sorting was then conducted to separate school or systemic influences from university learning and neuroscience based learning. Comparisons were then conducted between both interviews for each participant. Similarities and differences were noted. Further analysis was conducted across both interviews to look for similarities and differences in the data. These were compiled under the following categories: school, systemic influence, and university learning, a colour coding system was used. Further analysis was conducted to note the incidence of change between interviews at the group level. All information was recorded in a series of spreadsheets to assist pattern matching and trends. This data was then corroborated by comparing evidence from the participants' photographs and personal philosophical statements. School websites were used to corroborate information regarding curriculum influence and community expectations in the participants' respective school

contexts. During the conduct of the interview pattern matching processes, cross references were also made to the supporting data, photographs and personal philosophy statements, to confirm the connections and themes for the purposes of assuring validity through triangulation. Additional themes were noted as this process was conducted and appear in table form (See Table 8).

A system of double coding (Baxter, 2008) was employed after first full analysis to confirm earlier trends and patterns and increase dependability of the data.

Evaluative Criteria

The trustworthiness of a research study is established through credibility, dependability and confirmability (Lincoln, 1985). There are techniques for the establishment of each of these criteria.

Techniques used during this case study to establish credibility include extended engagement to develop a rapport and trust with participants that would facilitate an understanding and co-construction of meaning between the researcher and participants (Guba & Lincoln, 1981). Triangulation is another technique used by gathering information from multiple data sources in order to corroborate findings as a test for validity, in this case study triangulation is conducted after both Round One and Round Two Interviews, then using photographic evidence and personal philosophical statements as secondary data sources. Negative case analysis technique was used to search for elements of data that did not support explanations coming from data analysis this is shared in the findings of Chapter 4.

Dependability is established through an audit of data and a double coding technique. Double coding (Baxter, 2008) requires the researcher to code data in initial stages and return to the data to code again for cross checking purposes. This process was conducted to confirm all findings across participant interviews as well as across participants and schools after completion of an initial data analysis process.

In order to establish confirmability (Lincoln, 1985) the researcher has maintained a comprehensive audit trail, this includes raw data such as digital interview recordings and transcriptions, photographs of classrooms at each school and personal philosophical

statements provided by teachers. Beyond the raw data a spreadsheet of recurring themes has been collated and colour coded at individual interview interview and group levels. Checklists were developed to assist the double coding process. All schedules and notes have been filed for ready access if required. This audit trail has also supported the triangulation process mentioned above under techniques for credibility.

Conclusion

This chapter has provided an overview of the gathering and analysis process of the research data. The case study methodological approach has been considered and defended for the rich and 'thick' description it provides for the reader. The selection of the methodology was heavily influenced by the flexibility and authenticity this model provides for the educational context of the study. Ample detail and a chain of evidence provided in the appendices provides other researchers with information in order to replicate the conditions and procedures under which this study was implemented. The following chapter provides an analysis of the data gathered in the formats as described above.

Chapter 4 – ANALYSIS OF THE DATA

Introduction

In the previous chapter the case study methodology used in this study was described. This chapter provides an analysis of the data that has been gathered, this data analysis is discussed in the following chapter to assist the drawing of conclusions and consider directions for future research. Chapter Four reviews the research questions and sorts the findings into the following three levels: School or systemic influences, university learning and neuroscience supported practices for application to education contexts. There are patterns that emerge from the data at each of these levels, the case study level and the individual participant level. Participant level data is evident in a series of vignettes provided in this chapter these pictures clearly demonstrate the difficult and complex terrain of a teaching context.

The participants and their school context

This case study collected data from six different participants and sources. These sources were education contexts spread throughout Queensland. Each of the educators shared a common training background, the university, and a common program of study, the Bachelor of Education (BEDU). All participants completed their training program at the end of 2010 and were newly appointed to their school sites early in 2011. Each of their school appointments was a primary school setting, two of the six contexts were private schools with an independent curriculum. The remaining four schools followed state based curriculum guidelines.

One school context was a P-12 Catholic School in a provincial city using the Catholic Education Syllabuses. Another was an Independent P-12 School catering for international students, using the Primary Years Program (PYP) as their curriculum, a precursor to the International Baccalaureate. The four remaining schools were state primary schools in

diverse regions of Queensland including a small country school in an established farming community, a very large inner metropolitan school with a high percentage of students from English as a Second Language (ESL) backgrounds, a large school hurriedly established in a country mining boom town and a small Far North Queensland island community school.

Each of the early career teachers demonstrated different interests, experiences and educational priorities. Their teaching preferences varied and placements were similarly varied, ranging from one Preparatory year (Prep) class appointment to primary school classes including Years One, Two, Five and Six grade students. In two instances these educators were teaching composite classes in their first year appointment. Some participants had completed their university training directly after their secondary school education, whilst others have worked for some years prior to attending university and have established businesses and families prior to university study.

The findings to follow are focused upon the pedagogical practices of each participant and influences that have affected their selection of teaching practices in these educational contexts.

Addressing research issues

As stated in the previous chapter this study aimed to discover if the participants utilized previous university coursework related to neuroscience discoveries in their teaching practices. The two main research questions which guided the study were:

- How are first year teachers' teaching practice decisions influenced by their prior university learning and their current school context?
- To what extent, if any, do first year teachers incorporate and implement neuroscience supported practices in their teaching program?

In order to address the research questions, data was collected and analysed for themes that connected with current school expectations, general university learning over the four years of teacher training and then more specifically, neuroscience supported practices.

This data came from two rounds of individual interviews and artefact analysis from two data sources. Two additional themes were common across all sources and these will be shared later in the chapter as they relate directly to the respective participants' choices regarding their pedagogy. In order to fully investigate the research questions, analysis was undertaken at several levels, two of these levels included the individual and the collective group of educators. Much like viewing individual paintings within an art gallery, each has an individual contribution additional to the overall group 'picture'. The 'big picture' findings are presented here and developmental layers of findings are presented thereafter.

School or systemic expectations

The following section focuses upon aspects of relevance in this study in relation to school and systemic expectations.

Curriculum Considerations

In five of six instances schools provided the participant first year teachers s with community based curriculum documents for planning. These documents were in addition to the state created documents for Education Queensland and Catholic Education. In two instances (P2 and P6), school documents contained specific detail about the content and pedagogies expected of these teachers in their schools. The remaining three community curriculum documents included guidelines for community preferred teaching models for participants (P3, P4 and P5) Information regarding these directives was gathered during

Round One Interviews, the researcher then verified this information against school policies on websites and reconfirmation in Round Two Interviews.

School or systemic expectations: Curriculum Considerations	**Participants**					
	1	**2**	**3**	**4**	**5**	**6**
School controlled structured plans for the day including a regular routine		✓				
Community-based Curriculum		✓				✓
Community preferences			✓	✓	✓	
Explicit teaching of specified concepts requested by school or system		✓				✓

Table 1: School or systemic expectations: Curriculum Considerations

Table One summarises the incidence of occurrence across the sources, where school or community expectations were in place. In one instance the community required the teacher to follow a school established timetable and teach using models that were teacher delivery focused. This instance is unusual, most schools allow teachers to develop a personalized timetable incorporating school expectations of subject allocations.

Resourcing and physical design

All six participants received school resourcing to support the use of high quality technology through interactive whiteboards and computer access. Four participants cited school expectations included directives for the extended use of these resources. This can be seen in the figure presented below.

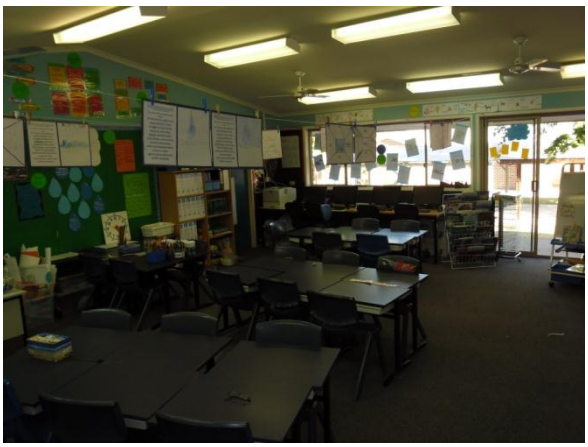
School or systemic expectations: Resources or Physical Structures	Participants					
	1	2	3	4	5	6
Incorporating use of ICT in classrooms		✓		✓	✓	✓
Floor spaces and desk arrangement in groups		✓				
Activity corners for differentiation, extension and student interest					✓	✓

Table 2: School or systemic expectations: Resources or Physical Structures

All of the participants provided artefact evidence through photographs that to some extent revealed their choices for catering for student needs. Two participants revealed that student differentiation was a high level school expectation. One example follows:

> They [parents] are quite heavily involved with a lot of the decisions that are made... they're not a very passive group of parents, they're very involved, very active in education and they regard it highly as an important aspect of their children's lives. A lot of small groups ... a lot of differentiation and the groupings of the children have really assisted with some children extending and other children just needing that extra time with aides and things. (P5, Round One Interview).

These two schools' expectations were reflected in the first year teachers (P5 and P6) operational practices and observable in their classroom structure as evidenced by photographs below showing activity and extension organization in classrooms.



School supported pedagogical practices

There were some common teaching practices that appeared in first year teachers preferred practices and school directives. In three instances, rote learning (P2, P4 and P6) and activity based learning (P2, P5 and P6) were selected because they were school endorsed models of teaching. One of the participants considered learning modalities (P2) which influenced the teaching practice model the teacher used with students. One school site policy included teaching practices that deliberately taught higher order thinking skills within the school program (P6).

School or systemic expectations: Pedagogical Practices	**Participants**					
	1	**2**	**3**	**4**	**5**	**6**
Rote learning and automaticity		✓		✓		✓
Learning modalities		✓				
Higher order thinking skills and cognitive organisers						✓
Constructivist models of learning, activity rotations and / or inquiry based practices		✓			✓	✓

Table 3: School or systemic expectations: Pedagogical Practices

The School influenced teaching practices listed in Table Three also present later as teacher selected options in *Table Four: University Learning* to illustrate differentiation between school decision and university learning choices.

Examination of school and systemic expectations regarding pedagogical choices revealed the following common themes: community expectations for curriculum based decisions; incorporating explicit teaching and differentiation strategies; using information and communication technologies (ICT) resources to support teaching practice; and use of rote and activity based instruction.

University learning reflected in practice

The two rounds of interviews revealed significant information at the university learning level and each round of interviews was analysed separately before combining the data to highlight overarching themes. This allowed the researcher to observe changes to the participants' practice during the course of the study. The participants all used structured plans and routines to guide their daily planning; however, in one instance this planning was also changed in response to student interest and was modified dependent upon the direction taken by student inquiry. This model of planning appeared to be more open than the other five sources.

From Explicit Teaching to Constructivist Learning Models

During the Round One Interviews, all educators used explicit teaching practices extensively. Significantly, 10 weeks later during the Round Two Interviews, most educators revealed they had reduced their instances of explicit teaching practice and increased their activity based, group work and other constructivist learning experiences. Constructivism is best defined as learning that is active and reflective. In essence, the teacher plans and provides opportunities for learning that allow interaction with the

environment or other stimulus to develop new ideas and concepts based upon their current understanding (Bruner, 1985). These practices were discussed and confirmed utilizing data from the interviews and photographs.

> I've run more hands on, more of the kids controlling...being in charge of the lessons. I did this for two reasons one because I was always losing my voice, the other was watching the class mature, they really got involved, more interested and engaged (P1, Round Two Interview)

Thinking skill development through use of cognitive organisers, and higher order thinking skills were highly considered by all of the participants regardless of the ages of the students. Three of the participants (P1, P2 and P4) mentioned this skill development in their initial interview. Artefacts such as photographs were used to confirm that these skills were taught and this investigation revealed that all of the participants did in fact teach a range of thinking skills, which was confirmed during the Round Two Interviews. This was a highly significant practice used to develop thinking in all of the participants' students in the study. In one case only (P6), thinking skill development was mandated as a policy directive of the school. Hence, the remaining five educators (P1, P2, P3, P4 and P5) made a judgement about the importance of this practice to their regular teaching pedagogy and incorporated this into their class routines.

> The main change I have made is in history. I seem to do inquiry (method) a lot …. pretty much individual or in small group research without me just telling them information.(P4, Round two Interview)

> We actually did a concept map today in class. We started the new unit ... then we got them to link to see if there were any similarities and how different areas of the community use the same kind of transport. It's the inquiry process we've got tuning in, sorting out, asking questions, reflecting, finding out..." (P6, Round Two Interview)

Educator decisions based upon university learning: Pedagogical practices	Round One Interviews						Round Two Interviews					
	1	2	3	4	5	6	1	2	3	4	5	6
Explicit teaching **(red indicates school or system expectations)**	✓	✓	✓		✓	✓		✓			✓	
Physical activity to improve learning	✓			✓	✓					✓	✓	
Learning modalities **(red indicates school or system expectations)**	✓	✓		✓			✓	✓	✓	✓		
Pair and small group work	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓
Use of higher order thinking skills and cognitive organisers	✓	✓		✓			✓	✓	✓	✓	✓	✓
Constructivist models of learning including activity rotations and inquiry based practices	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

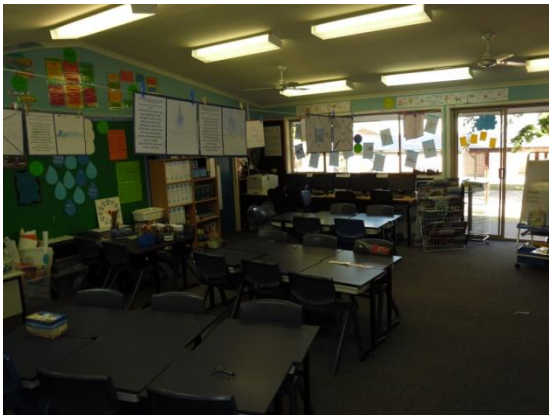
Table 4: Participants' decisions based upon university learning: Pedagogical practices

Table Four tracks the pedagogical changes of educators across the period between interviews. The coloured ticks differentiate between university learning and school or systemic influences. School and system influences are colour coded red. University learning coded black. In some participant cases the categories collated overlapped as university learning was also a school based expectation.

Resourcing and physical design

The physical layout of a room is often indicative of the type of interactions that students are encouraged to use, such as through the use of furniture. Desks placed in rows, encourages interaction between teacher and students as a whole class. Desks arranged in groups or clusters supports group discussion and group supported learning practices. In this study, desk configurations changed in the period between interviews, with the exception of the Prep Year teacher (P5) and the PYP (P6) teacher as the school policies for both these locations discouraged desks in rows from the outset.

The remaining four participants (P1, P2, P3 and P4) used a seating plan that incorporated desks set out in structured line formations which was revealed during the Round One Interviews and was supported by photographic artefacts. During the Round Two Interviews only one participant (P2) confirmed that they were still using desks placed in rows facing the front of the classroom. They revealed that this was due to a school policy directive that required this classroom layout: "I have my little corner desk near the door. From there we are in rows. That's the way the college wants it for kids, especially for explicit teaching – they're to be in rows facing the board." (P2, Round One Interview)



The traditional seating structure in the remaining five classrooms may not be indicative of the participants' teaching pedagogy but a response to early year class needs for encouraging attentiveness and discouraging noise and misbehaviour. In the conduct of both interviews and observation of artefact records, photographs and personal philosophical statements, it is most likely a combination of both the participants' pedagogy and behaviour management that were reasons for the structural adjustments of five in six classrooms.

> ...I'm keeping that there because they work well in that shape (U shape for desks), at the start it was a bit more of a surviving week by week thing ... they can't interact very well in a positive way. It's a good space to have where we can do role playing activities. Also, everyone can see

each others' face when they're having a class discussion about something. (P3, Round One Interview)

Educator decisions based upon university learning: Physical Structures	Round One Interviews						Round Two Interviews					
	1	2	3	4	5	6	1	2	3	4	5	6
Incorporating use of ICT in classrooms **(red indicates school or system expectations)**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Floor spaces and desk arrangement in groups **(red indicates school or system)**		✓	✓		✓	✓		✓	✓	✓	✓	✓
Activity corners for differentiation, extension and student interest **(red indicates school or system)**		✓	✓		✓	✓			✓		✓	✓

Table 5: Participants' decisions based upon university learning: Resources and/or Physical Structures

Table Five tracks the pedagogical changes of educators across the period between interviews. University learning is marked in black, red ticks indicate the school or system has influenced the decision in the same category. Data from both sources is provided to assist the reader with a view of the overall uptake in each category.

Participants' teaching practices unsupported by neuroscience research

Consideration of learning modalities featured in the planning and pedagogy of five participants (P1, P2, P3, P4 and P6). One participant (P2) was directed by local school policy and therefore used a pedagogy that was structured in a format of *I do*, *We do*, *You do*. It can be noted in articulating this practice in the classroom the teacher (P2) provides a visual and verbal demonstration of the concept to be taught, next the class and teacher perform the task together, thus incorporating an active component to the learning. The final stage called *You do*, is where students are asked to perform the task or demonstrate the concept themselves. This model is used extensively in Torres Strait schools through community and school teaching.

The remaining four participants nominated learning modalities in their planning and listed a variety of influences including Gardner's Multiple Intelligences, Auditory Visual Kinesthetic Learning Preferences or Hermann's Brain Dominance Model which underpinned their teaching practices. In all cases the participants were not limiting their teaching practice provisions to the preferred modality of the student or students, the teachers were using the modalities much like a checklist for ensuring good coverage of all options for the diversity in their classrooms, as evidenced in the following statement: "At the start of the year we did some tests [for] multiple intelligences as well as their learning styles. That was more of a start of the year thing just so we could understand how they learnt best." (P5, Round One Interview)

The following table contains a list of the teaching strategies unsupported by neuroscience research derived from the literature review in Chapter Two. Data from the participants reveal that no pedagogical consideration was given to any unsupported findings beyond the consideration of learning modalities, specifically in this study Multiple Intelligences and the Auditory, Visual and Kinesthetic model.

Teaching strategies unsupported by neuroscience research (identified in source data gathering)	**Participants**					
	1	**2**	**3**	**4**	**5**	**6**
Gardner's Multiple Intelligences				✓		
Mozart Effect						
Emotional Intelligence						

Left and Right brain learning preferences						
Use of Auditory, Visual or Kinesthetic (AVK) models for teaching activity selections **(red indicates school or system)**	✓	✓	✓	✓		✓
Brain Gym exercises are found to connect left and right brain functioning						
More synapses mean more brain power						
An enriched environment is necessary to enhance neural development						
There are critical periods for brain development and these relate to periods of high synaptic growth and pruning						
Periods of synaptic pruning have correlation with learning retention or memory loss						

Table 6: Teaching strategies unsupported by neuroscience research

Limited interest was demonstrated in the neuromyths uncovered in an exploration of the literature pertinent to this study, however far more frequent consideration of neuroscience supported practices was noted. This is expanded in the following section.

Participants' neuroscience supported practices

This study aimed to collect evidence of current pedagogical practices from a range of school sites and to review these practices in order to ascertain if university coursework, with a particular focus on neuroscience discoveries were incorporated in participants' teaching practices. The second research question which guided the study investigated the extent to which first year teachers incorporated and implemented neuroscience supported practices in their teaching programs.

The literature review in Chapter Two listed the neuroscience supported practices that have transferability to educational settings. These particular practices were used as a reference point when analysing interview and artefact data. The findings as revealed from the participants' data and their respective school sites are summarized in the table below.

Neuroscience discoveries utilized by participants in classroom settings	Participants					
	1	2	3	4	5	6
Thinking strategies are useful ways to encourage brain development and synaptic strength	✓	✓	✓	✓	✓	✓
The brain responds to variety and novelty when learning	✓	✓	✓	✓	✓	✓
Group work assists learning as students share knowledge and increases synaptic strength	✓	✓	✓	✓	✓	✓
Repetition or rote activity is useful for consolidating learning	✓	✓	✓	✓	✓	✓
Constructivism allows students to develop many parts of the brain simultaneously	✓	✓	✓	✓	✓	✓
Problem solving activities allow students to develop many parts of the brain simultaneously	✓	✓	✓	✓	✓	✓
Explicit teaching is supported by neuroscience research	✓	✓	✓	✓	✓	✓
There is a visual and auditory connection in learning	✓	✓		✓	✓	✓
Eating well enhances blood flow to the brain, thereby increasing brain activity				✓		
Water hydrates the brain and is necessary for optimal brain activity				✓	✓	
Limited sleep affects brain function				✓		
The amygdala is the source emotional peptides which influence brain function					✓	
Memory is affected by synaptic strength	✓		✓			
Strong synaptic connections indicate a brain that is working more efficiently	✓		✓			
Brains tend to follow the same synaptic patterns and we have to deliberately make a decision to interrupt the natural wiring to change habits and behaviours	✓	✓				
The brain is the most gendered organ of the body. Boys and girls use different parts of the brain to complete similar activities.						
General exercise has been found to be supportive of brain function				✓	✓	

Table 7: Neuroscience discoveries utilized by participants in classroom settings

Thinking skill development through use of cognitive organisers, and higher order thinking skills was highly considered by all of the participants regardless of the ages of their students. This was noted in the section above which highlighted how university learning was incorporated into the participants' teaching practices. The decision to teach particular thinking skills and strategies is indicative of the priority that all the participants give to opportunities which allow students to learn problem solving practices. Photographs below clearly show the use of a variety of thinking strategies for problem solving.

Repetition, rote and explicit teaching were acknowledged by teachers as important aspects of teaching practice. Whilst there was unanimous recognition of these specific teacher focused teaching practices there was also an equivalent recognition of the importance of group work, hands on activities and constructivist practices and their role in incorporating the student as a partner in the learning process.

Five participants (P1, P2, P4, P5 and P6) indicated they made consideration for connecting visual and aural information simultaneously to students to support diverse student learning needs. Whilst some students respond well to information delivered in spoken form, others needed a visual connection to learning. Other students respond best when visual and verbal strategies are incorporated together to assist in their learning.

In one case (P4) Round One Interviews did not reveal this information. However, after the photographic and philosophical statement artefacts were reviewed and utilized in Round

Two Interviews, all of the participants confirmed they used group work, constructivist practices, problem solving, thinking strategies, variety of experiences to assist learning, repetition to consolidate, explicit teaching and visual and auditory practices in their pedagogical choices. "Other graphical organisers... we've looked at word walls, pie graphs, line graphs...all different ways of representing what they liked the most and then one child writes a reflection ..." (P5, Round 2 Interview)

Group work, problem solving strategies, constructivist practices and thinking strategies were evident in the photographs through classroom structure, displays and observable classroom resources. These practices were also verified through use of the participants' personal philosophies and interview data. The Table Seven categories of novelty, explicit and repetitive practices were noted in Round Two Interview responses and confirmed through the analysis of participants' personal philosophical statements.

Participants (P4 and P5) also connected with the importance of exercise, water, food and sleep for optimising learning. Two of the participants (P1 and P3) considered synaptic growth as part of their teaching practices. In both cases this information was shared with the researcher at interview and it was revealed that the participants perceived this information to be of direct relevance to their students' needs. This may indicate that teachers were only articulating their neuroscience knowledge when this was directly applicable to the requirements of their students at the time.

Some paintings in the gallery

Each participant also presented information unique to the school site in which they taught. This information was connected to the research through the pedagogical implications for the class or student need. The compilation and analysis of this information is more about the individual paintings (participants) and less about the gallery (school sector) to continue a metaphor used in the introduction, but at this level these snapshots are considered useful to support the findings of this study.

Painting 1: A motivated researcher

Damien is a student in Participant 1's Year 2 class. This young student has foetal alcohol syndrome (FAS). His condition was not known when the educator first accepted the class and it took some time to find effective ways to manage the classroom space. Damien was constantly in trouble in the playground and difficult to manage in class. After months of frustration and attempts at addressing specific behaviours the school received a visit from a district behaviour support teacher who discussed of possibility of foetal alcohol syndrome. This motivated the first year teacher participant to research the effects of FAS on the brain. This research informed her pedagogical approach for dealing with the learning and range of behaviours from Damien that had affected the class for months. At the time of the Round Two Interviews the first year teacher participant revealed that Damien is no longer constantly in trouble and his learning is improving:

> ... his reading has moved from benchmark three to seven. We celebrated the other day. His name is not coming up in the playground anymore, he is starting to understand the difference between making a good choice and a bad choice ... (P1, Round Two Interview)

The educator has been motivated by the urgent need to make changes to pedagogical practices that were not working for Damien. In investigating this classroom dilemma the research has led the educator into neuroscience possibilities to account for the behaviours. This specialised focus was one example where neuroscience discoveries were considered in order to problem solve a significant medical issue with ramifications for a student's learning.

Painting 2: In a school far, far away

There are a series of remote islands in the Torres Strait that use a community curriculum to teach their children with the full support of the state school system. Teachers are appointed via the standard Education Queensland Human Resources protocols and these teachers are supported by local community teachers and elders. The system is deliberately designed to match the community teaching methods used for learning traditional Torres Strait Islander arts. Educators follow strict guidelines of routine and explicit teaching.

This may be considered by some teachers as restrictive and old fashioned, however teachers are carefully selected for appointment to this area and Participant Two has taken these pedagogical challenges in her stride. "[We are...] a new graduate school, but that was the Principal's choice... we're all straight out of university with all our ideas and we've never been anywhere else, so this is – I'll mould you". (P2, Round One Interview)

Regarding the pedagogical expectations of the community curriculum Participant Two revealed:

> ... it is a bit restrictive in ways of creativity and using your own way. I'm finding it being a first year teacher and just coming out, it's actually quite nice to have it [curriculum] all and then by doing that you're focusing on how you teach and your classroom behaviour… (P2, Round Two Interview)

This vignette is an example that indicates some educators have less autonomy over some pedagogical decision making than might be expected. It appears that for this participant the school and systemic expectations have directly influenced the selection of pedagogical practices based upon context.

Painting 3: Starting big school

Prep classes have only been in mainstream Queensland schools for 4 - 5 years. Prep classes are based on a play based curriculum which is designed to be a very flexible, incidental teaching year with limited formal pedagogy being used. In an inner city prep class with high socio-economic status and reputation, expectations can be even higher to move into formal education earlier than waiting until students move on to Year 1. "We've had a real push from higher authorities to have our Prep's reading well as soon as possible. So we're quite a structured classroom, more grade one I suppose than preps that I've previously seen." (P5, Round Two Interview)

In this classroom context between the two interviews, students have moved to a more formal learning environment than the play based curriculum. Every minute is structured to be useful and activities and transitions (moving from one lesson to another) are used as teachable moments. “So transitions have been a huge strategy to get children to move from one activity to the other while still participating in some sort of learning.” (P5, Round Two Interview)

Our educator has not only modified the learning activities and her pedagogies to suit her ‘clients’, she has also reviewed brain based learning considerations such as using water breaks and increasing blood flow through movement thereby supporting brain function.

> The Rhyming Rumba between the two activities was to really get the kids up and get the blood moving back to our brain and release some of that energy. This age group in particular sitting too long, you lose them after 20 minutes. So, the idea of lets go get a drink, let’s go to the toilet, have a run, seem to really refocus them for the last half hour. I suppose that I was quite shocked at how much of an improvement it made in having that 10 minutes. I think I underestimated its importance. I would never sit that long again. I think it really has shown a huge difference (P5, Round Two Interview).

These considerations are now factored into the daily routine between lessons thus creating a noticeable difference in students focus and application.

This vignette is an example that may indicate the educator is heavily influenced by community expectations in selecting useful pedagogies to increase student learning and has discovered that neuroscience discoveries that water and activity are useful for re-oxygenating the brain and increasing focus and productivity.

Additional findings

One generalised theme to present consistently during the study was that of social skill development. Initially four of the participants (P1, P3, P4 and P5) were teaching social skills as a deliberate and considered practice to support their students. Each of these four participants articulated class needs as the basis for adopting a social skills program. Each participant believed that teaching social skills and sound classroom behaviour management were interwoven and each of these four educators teaching a social skills program was doing so to support student behaviour in class.

Beyond a social skills program it was discovered through Round Two Interviews that all six participants were heavily involved in either the local school based behaviour management committee (P1, P3, P4 and P6) and /or behaviour management professional development sessions (P1, P2, P3, P4 and P5).

One of the participants (P4) had funded themselves to attend a focused professional development course on building self esteem and resilience to support the class behaviour program. Of the two participants (P2 and P6) that were not teaching a social skill program one (P2) articulated the need to use sound behaviour management strategies to manage their classroom, the other (P6) was reading additional information and considering undertaking training courses in the behaviour management field.

Educator decisions based upon university learning: Social skills	Round One Interviews						Round Two Interviews					
	1	2	3	4	5	6	1	2	3	4	5	6
Resilience and social skill development	✓		✓	✓	✓					✓		

Table 8: Participants' Decisions: Social Skills

The final common theme to present in the data was the general consensus from the participants, of feeling time poor regarding the making of quality pedagogical decisions. All participants alluded to making decisions and reflecting 'on the run' rather than having a quality discussion with peers or keeping a journal for consideration. Three different educators articulated this dilemma in the following ways:

> ... sometimes you just don't have the time to sit you know, you reflect on the surface but you don't have the time and do what you really want to do. (P1, Round One Interview)

> I still find I'm wishing there were a lot more hours in the day... (P2, Round One Interview)

> I think it's hard to find the time to sit down and have a nice chat because the other things 'go, go, go'. But, I constantly reflect in the car, in the gym. You know I'm thinking about what I've done today or what I'm doing tomorrow or how could that be done differently... (P5, Round Two Interview)

Time and behaviour management issues are consistently reflected in the interview data as impacting on pedagogical decisions. The context appears to be all important in the decision making processes of professionals in the education field. Selecting best practices for teaching appears to be highly reliant upon the options available to teachers after assessing class behavioural needs, time and school or systemic restrictions.

Conclusion

Analysis of the data would indicate that there are a number of schools or systemic expectations that influence the pedagogical decisions of educators, particularly in terms of this study, first year teachers. Of the six participants teaching across the primary age

group of students aged from five to 12 years, time and behaviour management issues in the classroom have a profound effect upon the participants' teaching practices. School or systemic expectations regarding teaching content and pedagogy provide another level of complexity for the participants. The most prevalent examples of school or system directives were community curriculum, expectations and preferences for explicit teaching models and differentiating for individual student needs.

The analysis of the data in relation to teaching practices was based upon university learning and included patterns such as increased use of group work as a valuable learning experience. This involved reorganising classroom structures such as desks and activity centres. The consideration of learning modalities to support pedagogical approaches to support student learning and interest and the specific focus upon teaching thinking skills to develop higher order thinking in any and all age groups was also evident in the data.

Neuroscience supported practices were most commonly incorporated into classroom practices through the teaching of thinking strategies, provision and consideration of variety in content and activity selection, operating activity based group work, use of repetition and rote teaching strategies, developing constructivist and problem solving learning opportunities, using explicit teaching when required and considering complimentary modalities of visual and auditory models when providing learning opportunities.

Whilst there is sometimes an overlap between university learning and school expectations when it comes to educators selecting teaching practices to support classroom learning, it is often seen that the directives at the local or system level heavily impact the pedagogies teachers have available to choose from. Discussion and conclusions are drawn from these findings in the following chapters.

Chapter 5 – DISCUSSION

> *In the last decade, there has been a fundamental shift in who teachers are, what they teach and how learning is delivered. This fundamental shift in learning, from students as mere receivers of teacher's knowledge, to students who explore and contribute to their own learning has made this a much more stimulating and exciting experience for students. However, it has also made quality teaching a complex and challenging task.*
>
> (P2, Professional Statement)

Introduction

The previous chapter analysed the data gathered from six first year participant teachers and their pedagogical practices. This data was reviewed for pattern matching on three levels that would directly address the research inquiry questions. Those three levels were school or system, university learning and neuroscience supported practices from their university coursework.

In proceeding to discuss and ultimately draw conclusions to the findings shared in Chapter Four it is important the researcher restates their interest in this research. The researcher's background for more than 30 years was as a primary and secondary educator across Australian states at varying levels of practice from teacher to school administrator and as a provider of professional development for teachers. This familiarity with the education context has been used to interpret the data, including the nuances of influence that impact on the education context but are often rarely seen or described to those beyond the education field.

The remainder of this chapter addresses a discussion of the research questions.

Influences upon decisions about teaching practice

The first research question of the study asked: *How are first year teachers' teaching practice decisions influenced by their prior university learning and their current school context?*

In order to address this research question interviews were structured to investigate what teaching practices were adopted by educators in their first year of teaching and then to consider the influences that determined those selections during the ten weeks of data gathering, from six participants. The interviews were corroborated by photographic and professional statement artefacts from each source. From this data a number of patterns emerged that were grouped for analysis into the categories indicated by the research questions.

Review of school and system expectations

The first research question looked at the influences of prior university learning and current school context. There appear to be a number of school or systemic expectations that influence the pedagogical decisions of educators. These include school or systemic policy or directives that are community curriculum preferences including teaching models.

Community influence

These school and system influences ultimately affected the teacher's opportunities to select from a broader range of classroom practices thereby impacting upon the use of other options including prior university learning. For instance, two participants operated at the school level using community specified curriculum. Both are very structured environments but for entirely different reasons. The first participant (P6) works in a mid to high socio economic community with limited behavioural issues. The curriculum in use is a PYP curriculum designed to foster higher order thinking and an inquiry model of

teaching. The teacher therefore is obliged to teach within the model, this affects physical room design, curriculum considerations and pedagogical practices that can be selected by the teacher.

The second participant (P2) is located in a remote island community school that teaches traditional life skills and cultural community programs, the school curriculum is heavily influenced by local elders. This curriculum expects students to be taught with consideration of traditional methods. The educator is afforded limited freedom to select content or pedagogy. Both of the examples above whilst vastly different are directly connected in each instance to meeting the expectations of the local community curriculum.

Schools provide technology resources for classroom use and also expect teachers to make due consideration for the different needs of their class. These expectations are incorporated into the teaching and learning activities that can be designed and implemented by educators. In several instances teachers were given explicit instructions regarding the extensive use of the technology that was made available to them. This instruction affects the selection of teaching pedagogies that teachers are asked to promote in their context.

The consequence of localised directives then limits the educators' options for pedagogical selection back to within the limitations of the local curriculum. In many ways this is a positive for the local community as they will see their needs met however, the professional educator may have an extensive repertoire of pedagogical practices that will never be used in these contexts.

Classroom Influence

As well as these school level expectations there are the more localised class organisational limitations created by students with poor behaviour and the resulting time spent dealing with poor behaviour rather than providing quality teaching experiences. Teacher time and

behaviour management affect the day to day organisation of the class routine and viable classroom activities.

Another example of influence upon pedagogical choice was evident from one participant where the school wide behaviour support program restricted the classroom management of misbehaving students to a school endorsed process of consequences for aberrant behaviour. In this case the ability of the educator to deal with a classroom issue 'in house' is restricted to the school behaviour model, thereby, limiting response options and affecting student teacher connectedness.

Two participants had been allocated composite classes (two grade levels in the one room) to manage as a first year teacher. Both these participants needed to be mindful of the larger than usual range of student abilities and grade and school agreed content per year level. In some instances the needs of students varied across three chronological years and even more ability levels. All these factors affect the teaching strategies that are used by the participants concerned.

Review of findings from university learning

The university learning that presented most frequently in the patterns of analysis included the use of group work as a structure to learning activities, consideration of learning modalities to cater for student needs and thinking skills development. In many cases educators who relied heavily upon explicit teaching at initial data collection had moved into an activity based, group learning model more often over the ten week study. Group work, considered as a pedagogical choice was found to increase between the Round One and Round Two Interviews. Teachers provided greater flexibility within lesson structures and made students more responsible for their own learning over time.

Constructivist practices were more observable in photographs and interview data by the end of the study. This may be related to several factors, the first being a more relaxed educator as the year progresses. Another reason may be with increasing familiarity and interaction the teacher has grown to know more about their students and their needs. Also,

in the early career phase of many teachers there are additional tensions regarding sourcing and planning quality lessons and a disinclination to release control of student activity. Additionally, student behaviour and familiarity with the teacher's behavioural expectations increased and students settled into a more productive routine with a regular teacher whom they understood and responded to more readily.

A variety of learning modalities were considered in more than half of all sources. This consideration led teachers to plan activities that covered a range of practices which provided greater variety to their lessons. The range covered practical learning activities (constructivism) and visual stimulus as well as auditory explanations but also included a range of different ways to cater for varying interests and to keep students engaged. For example, completing some lessons outdoors, as an individual, paired or in larger group structures, use of multimedia options or consideration of student interest might have influenced the content or pedagogical selections of the teacher.

The final major pattern to emerge under a heading of university learning was the teaching of higher order thinking skills and cognitive organisers. Cognitive organisers are structured ways to scaffold the learning needs of students as they learn to think and problem solve in different ways. The use of these strategies supported the students to extend their thinking processes and ultimately to think and deal with opposing positions and high level reasoning. Teaching these thinking skills was common pedagogical practice across all sources.

The direct effect of a more diverse range of lessons was found in each participant's classroom layout. This was needed to respond to the variations implemented for class activity, for instance desks in rows became desks in clusters.

It could be concluded from the practices adopted by these early career educators that when afforded the flexibility to teach as they would like to teach they strive to extend the thinking capacity of their students by scaffolding the development of good reasoning skills and creating opportunities for student led construction of learning through group activity. These early career educators are heavily influenced by the dynamics of school

contexts and this provides boundaries around choices of the pedagogies they are able to implement.

Review of the neuroscience influence on teaching practice

- The second research question of the study investigated: *To what extent, if any, do first year teachers incorporate and implement neuro-scientifically supported practices in their teaching program?*

Drilling down into the data that was gathered through interviews and artefacts revealed that neuroscience supported practices are incorporated into classroom practices through the teaching of thinking skills and problem solving strategies. To teach thinking skills and problem solving strategies, teachers chose to operate activity based group work and use models that reinforced students' opportunities to construct their own knowledge.

Repetitive practice and rote teaching strategies were selected to support spelling and mathematical learning. Explicit teaching was often used to introduce new concepts or provide additional student support. Selecting explicit or discovery based learning opportunities, as cited above, in such variety indicates the expanding repertoire of the teacher as well as a developing comfort around their pedagogical selections as the year progresses and their skills increase.

In many instances the educators did not even identify the neuroscience background to the success of the selected pedagogy but simply used this strategy as a sound practice. Teachers were able to identify many neuroscience supported strategies that they used in their everyday teaching practice however, they did not select the strategy itself based upon the endorsement of neuroscience. In fact, in several cases the researcher actually identified the neuroscience principles behind the pedagogies selected to assist the educators to make the connection between theoretical evidence and sound practice. In each case the teacher acknowledged they had previous knowledge of the connection but it had not featured in their decision making.

In most cases educators recalled understanding that brain wiring represented the plasticity of the brain and the ability of the brain to continue to change and learn. One only in six sources actively used brain awareness to support teaching practice for the class activities and this was in using water, movement and blood flow connections to focus and concentration. Other sources used their awareness of brain function to investigate specific student needs such as foetal alcohol syndrome or to support student behaviour or self esteem practices.

The data related to the second research question regarding implementation of neuroscience supported practices would therefore indicate that educators choose sound pedagogical practices rather than neuroscience supported practices, some of these choices however have a neuroscience background. If this is the case, then the implications for more specific and targeted knowledge regarding neuroscience and the neuroscience application to teaching needs to be addressed more explicitly, as teachers were unable to articulate the research behind why they had selected the choices they made.

Conclusion

This discussion chapter reviewed the research questions and considered the trends present in the data analysis. This discussion covered the major themes of school and systemic influence, university learning and university learning of neuroscience discoveries applicable to educational practice. The following chapter draws implications and conclusions from the data analysis and discussion.

Chapter 6 – CONCLUSION

The preceeding chapter has discussed the research findings. This, the final chapter draws implications and conclusions from the data analysis in Chapter Four and the discussion in Chapter Five. Further research is proposed to consider replication of the data in a wider sampling that may benefit both educators and neuroscientists.

There are a number of schools or systemic expectations that influence the pedagogical decisions of educators, particularly in terms of this study, first year teachers. The most prevalent examples of school or system directives were community curriculum, expectations and preferences for explicit teaching models and differentiating for individual student needs.

As a degree of familiarity grew between teacher and class the teaching practices utilised included the increased use of group work as a valuable learning experience. University learning and Neuroscience supported practices were most commonly incorporated into classroom practices through the teaching of thinking strategies, variety in content and activity selection, activity based group work, repetition and rote, constructivist and problem solving learning opportunities. Most of these practices became more frequent as familiarity developed between teacher and class.

In order to encourage the implementation of neuroscience supported practices in classrooms teachers need to develop greater familiarity with the useful content. There were a number of patterns that emerged from the research including the need for explicit teaching of neuroscience concepts to promote teacher adoption for classroom use. These implications are discussed below.

Implications

Providing explicit and more extended training of neuroscience discoveries and their application to education would provide a more scientific basis for teachers to use when

considering and selecting their teaching practices. Practices would be made upon the basis of the scientific underpinnings, in full knowledge of their application and effective use in education contexts. This connects to themes from the literature review where many researchers (Ansari & Coch, 2006; Geake & Cooper, 2003; Howard-Jones, et al., 2008; Murphy & Benton, 2010; Twardosz, 2007) have determined the need for ongoing professional development for teachers and training in undergraduate programs as priorities.

We must begin to share a common language which will add perspective to both fields. A concerted effort to hold regular professional development for teachers and train our university graduates within the program is an important step in assisting educators to understand the potential and limitations of neuroscience application to mainstream classrooms. This common language and understanding of neuroscience application must be based upon scientific findings not brain based packages and strategies that are unsupported by neuroscience research (Ansari & Coch, 2006; Geake & Cooper, 2003; Howard-Jones, et al., 2008; Murphy & Benton, 2010; Twardosz, 2007).

Furthermore, the research would suggest it is important to provide accessible neuroscience knowledge to the lay community, particularly those that may have an impact upon community curriculum choices. If some educators have limited options for teaching practice selection and this is related to community expectations or directives then neuroscience research must also be shared beyond the education field. This extended sharing of research will assist all stakeholders, educators and community, to consider application of findings to specific context when making decisions that influence education policy.

It must also be remembered, this research indicates that teachers make pedagogically reliable decisions for many reasons, only one of these reasons may be that the learning may be neuroscience supported. Other reasons may include decisions made simply because teachers have observed a particular practice is working with their students. Educator decisions are applied to classrooms immediately as they are both proactive and reactive to student need, this is an action research model. Educators will continue to use

practices where they see their students learn successfully, these teachers are teaching now. They cannot wait for neuroscientists to discover all the answers before proceeding or selecting teaching practices for today and tomorrow. This proposition is fully supported by (Coch & Ansari, 2009; Mason, 2009; Murphy & Benton, 2010; Tommerdahl, 2010) who believe neuroscience is one useful source and should be used alongside other methodologies.

This 'gap' between the fields of education and neuroscience will close as more is discovered and can be applied to education contexts. In the meantime, there will be a transition in educator practices from older to newer methods of teaching. The progress of this transition is directly reliant upon the speed of neuroscience discoveries, transferability of these discoveries to educational contexts and a continuing effort being made to empower the educator and interested community through the sharing of scientific discovery.

Conclusion

There are more questions than answers in interpreting the data from the case study conducted with six participants across six school sites in Queensland. These ongoing questions provide the basis for future research into the application of neuroscience discoveries to education contexts.

This case study was limited to six first year teachers, but it would be useful to know if the findings gained here might be replicated across other sources including established teachers and even secondary and tertiary teaching contexts.

Two questions which have arisen from this study and would be important in relation to future research are:

- What difference does it make if the neuroscience information for educators is shared more explicitly and to a greater depth during university training programs?
- What difference does it make if neuroscience research is shared with current educators in conference settings for application when they return to their classrooms?

These questions provide a focus for future research regarding teachers' teaching practice decisions and neuroscience application to the mainstream classroom. It is also hoped that this research may inform neuroscientists about the contextual difficulties teachers experience daily in their quest to provide meaningful learning experiences for students and the type of pedagogical research educators would be most likely to apply to their settings.

The project's initial aims were to investigate how newly graduated teachers were using brain research, in their first year of teaching, to inform their classroom practices. This case study has determined there are many influences upon teacher selected pedagogy including school and system expectations as well as prior training in effective teaching practices. Many teacher decisions are highly contextual and if neuroscience is to be part of teachers' considerations explicit training will be required.

The researcher wishes to acknowledge the wonderful teacher participants who have shared their experiences in support of the research. It is hoped that their legacy through this case study might provide a small step in closing the research gap for educators and neuroscientists.

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APPENDIX

APPENDIX 1

Ethics Approval

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OFFICE OF RESEARCH AND HIGHER DEGREES
William Farmer
Ethics Officer
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EMAIL ethics@usq.edu.au

Tuesday, 18 October 2011

Jenny McIntyre
Faculty of Education
USQ Springfield Campus

Dear Jenny

The Faculty Ethics Chair recently assessed your application and agreed that your proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research (2007)*. Your project has been endorsed and full ethics approval granted.

Project Title	"Miss, my brain hurts!" Rewiring our teaching practice
Approval no.	H11REA095
Expiry date	01/10/2011
Faculty Decision	**Approved as submitted**

The standard conditions of this approval are:

(a) conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the HREC
(b) advise (email: ethics@usq.edu.au) immediately of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project
(c) make submission for approval of amendments to the approved project before implementing such changes
(d) provide a 'progress report' for every year of approval
(e) provide a 'final report' when the project is complete
(f) advise in writing if the project has been discontinued.

For (c) to (e) forms are available on the USQ ethics website: http://www.usq.edu.au/research/ethicsbio/human

Please note that failure to comply with the conditions of approval and the *National Statement (2007)* may result in withdrawal of approval for the project.

You may now commence your project. I wish you all the best for the conduct of the project.

William Farmer
Ethics Officer
Office of Research and Higher Degrees

Ethics Approval for Amendment: Email Confirmation

From: Ethics
Sent: Friday, 26 August 2011 4:34 PM
To: Margaret Baguley
Subject: RE: Amendment to project

Dear Margaret

The Ethics Chair has recently reviewed your application for amendments to approved project "Miss, my brain hurts!" Rewiring our teaching practice" *(H11REA095)* as stated in your memorandum dated 17/08/2011. The requested amendments have been endorsed and full ethics approval has been granted.

Your amendment approval number is H11REA095.1

Ethics approval for the project expires on 01/10/2011

The standard conditions of this approval are:

(a) conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the HREC
(b) advise (email: ethics@usq.edu.au) immediately of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project
(c) make submission for approval of amendments to the approved project before implementing such changes
(d) provide a 'progress report' for every year of approval
(e) provide a 'final report' when the project is complete
(f) advise in writing if the project has been discontinued.

For (c) to (e) proformas are available on the USQ ethics website:
http://www.usq.edu.au/research/ethicsbio/human

Please note that failure to comply with the conditions of approval and the *National Statement on Ethical Conduct in Human Research (2007)* may result in withdrawal of approval for the project.

You may now implement the amendments. I wish you all the best for the conduct of the project.

Regards

William Farmer
Ethics and Research Integrity Officer
Office of Research and Higher Degrees
University of Southern Queensland
Phone: (07) 4631 2690
Email: will.farmer@usq.edu.au

APPENDIX 2

Ethics Participation and Consent Forms

Please double click to view entire document

University of Southern Queensland

The University of Southern Queensland

Participant Information Sheet

HREC Approval Number: H11REA095

Full Project Title: **"Miss, my brain hurts!" Rewiring our teaching practice**

Principal Researcher: Dr Margaret Baguley

Other Researcher(s): Jennifer McIntyre

My name is Jenny McIntyre and I would like to invite you to take part in my Masters Research Project titled : 'Miss, my brain hurts! Rewiring our teaching practice'. This study will investigate how the brain learns by investigating current teaching practices and to what extent teachers implement brain research in their classrooms. You are invited to participate in this research project because of your current knowledge regarding brain research during your education program at USQ and your current position as a teacher in a school setting.

Please read this Participant Information Sheet carefully. Its purpose is to explain to you as openly and clearly as possible all the procedures involved so that you can make a fully informed decision as to whether you are going to participate. Feel free to ask questions about any information in the document. Once you understand what the project is about and if you agree to take part in it, it is asked that you sign the Consent Form. By signing the Consent Form you indicate that you understand the information and that you give your consent to participate in the research project.

1. Procedures

Participation in this project will involve

- Two semi-structured phone/Skype interviews of 30 minutes duration approximately 10-12 weeks apart.

This research project forms part of Jenny McIntyre's assessment for the Masters program and as such will be supervised by Dr Margaret Baguley and the Human Ethics Committee at the University of Southern Queensland

- *The possible benefits for participants will be they are able to articulate their understanding of effective teaching and learning practices and identify these practices in their classrooms. Participants will also gain an increased awareness of current brain research and the implications for teaching practices which can enhance educational outcomes for their students. The reflective practice undertaken by the participants can also be seen as an important professional development opportunity.*

- *The possible risks to participants is quite low as all data will be de-identified, pseudonyms will be used for participants and any information in the photographs will be obscured so that the school is not inadvertently identified.*

APPENDIX 3

Semi Structured Interview Questions. Round One Interview

1. Could you please provide a brief description of the school you are currently teaching in to help me understand your teaching context?
2. Could you please describe your classroom's physical structure including its layout, signage, decoration, student work, resources and any further details you believe to be important?
3. Please describe your regular classroom routine and how you structure what the children are learning throughout the day/week.
4. What are the preferred teaching methods you use regularly and why do you use these particular methods?
5. What knowledge from your education program at USQ have you incorporated into your current teaching approach and practice?
6. Can you recall any knowledge you have of how the brain actually learns from your USQ program or from other sources? Has this knowledge informed what or how you teach?
7. What knowledge have you drawn from working in the school context that you have incorporated into your current teaching approach and practice?
8. Have you undertaken any teacher professional development that you think could be relevant to the focus of this research project? If so please describe them.
9. Have you pursued any professional reading in relation to the focus of this research project such as catering for different learners and thinking styles?

Semi Structured Interview Questions. Round Two Interview

1. Last time we spoke, we discussed your teaching practices and learning. What elements within the physical layout of the classroom have you changed (if any) since this time? If so, can you please explain why these changes have been made and if not please explain why you have not felt the need to make any changes.
2. Have you changed anything about your regular classroom routine since our last interview? If so, can you please explain why these changes have been made and if not please explain why you have not felt the need to make any changes.
3. Have you changed your 'standard' teaching approach and/or methods since our last interview? If so, can you please explain why these changes have been made and if not please explain why you have not felt the need to make any changes. Where did the impetus for these changes come from, e.g. prior university learning, school context, professional reading?
4. Since our last interview have you pursued any information on how the brain actually learns? If yes, how has this influenced what or how you teach?
5. Has your participation in this research project made you reflect more on your teaching approach? If so, please briefly explain.
6. Would you describe yourself as a reflective practitioner? If so please explain why and if not why you do not see yourself in this way.