GET MOVING IN MATHS: ENGAGING STUDENTS IN ACTIVE MATHEMATICAL EXPEREINCES

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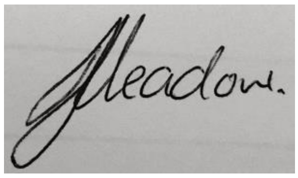
DECLARATION

I certify that this dissertation contains no material that has been accepted for the award of any other degree or diploma in any institute, college or university. In addition, to the best of my knowledge and belief, it contains no material previously published or written by another person, except where due reference is made in the text of the dissertation.



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ABSTRACT

Rates of student participation in mathematics are declining, especially at the tertiary level, where in some states in Australia students' have the option to choose mathematics. Recent research also suggests that students as young as nine are expressing negative feelings towards mathematics (Larkin & Jorgensen, 2015). A recommendation from researchers is to enable teachers of mathematics to implement pedagogical strategies, which engage students. The aim of this research project was to investigate whether there is a link between purposeful movement within mathematics and an increase in overall student engagement. This was investigated from the perspectives of both the participating teacher and her class of Grade 1 students.

The results showed that students were highly affectively engaged in mathematics learning when movement was present. In fact, one of the main findings of this study was the high level of interest and very low levels of frustration identified by the participating students when undertaking mathematical activities. This is of relevance for educational professionals as it suggests that purposeful movement within mathematics has the potential to increase interest and decrease frustration, which could be a factor in slowing the decline of engagement in mathematics.

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Chapter 1

Introduction

April (age 6): Something that helped me learn was running around in Miss O's group… it made me very happy and proud.

This chapter outlines the importance of the research, both personally and theoretically. It begins by discussing the background of traditional mathematics classroom teaching. Following this, a personal justification for the study is stated, along with research questions, definition of terms, background and significance of the research. Finally, the chapter outlines the limitations of the study.

Brief Background

This educational research focused on the need for more understanding related to increasing student engagement in order to effectively and authentically improve learning outcomes in mathematics. Until recently, much of the research surrounding student engagement in mathematics has been based in secondary schools, where students have the choice to further their mathematics education (Attard, 2011). A significant concern for the government is the falling rate of students choosing to participate in higher-level mathematics education (Larkin & Jorgensen, 2014). Of particular concern, a recent study in an Australian school in Queensland discovered that strong negative feelings towards mathematics were expressed from students as young as nine years of age (Larkin & Jorgensen, 2015). This should be a huge concern for educators. If students as young as nine are showing a negative association with mathematics then they are likely to become disengaged very quickly and less likely to choose mathematics in post-secondary and tertiary studies (Larkin & Jorgensen, 2015).

One of the recommendations from the research of McPhan, Morony, Pegg, Cooksey, and Lynch (2008) was to enable teachers of mathematics to implement pedagogical strategies which engage students. However, the complexity of engagement needs to be considered when implementing strategies to engage students.

Generally, mathematical practice in schools in the past and often still in today's society mirror a model of 'transmission' where the teacher typically includes textbook use, rote learning and worksheets into their lessons (Walls, 2005). However, research demonstrates that teachers should move away from 'chalk and talk' strategies and implement more meaningful learning activities (Ransom & Manning, 2013; Stigler & Hiebert, 2009). Improvements are being made, however there are still some students whose educational needs are not met, specifically those with a kinaesthetic learning style (Spielmann, 2012). Additionally, many teachers feel the need to teach to the test, due to underlying pressures of student performance on government standardised testing, specifically NAPLAN (Australian Curriculum and Reporting Authority [ACARA], 2015). This transmission mode of teaching does not reflect an holistic approach (Tinning, McCuaig, & lisahunter, 2006). These may be some of the underlying reasons why teachers have not been catering for kinaesthetic learners, and as such their academic performance has suffered (Speilmann, 2012).

The main aim of this research project was to investigate whether there is a link between purposeful movement within mathematics and an increase in overall student engagement. This was investigated from the perspectives of both the participating teacher and students.

Definition of Terms

Engagement: To define engagement is highly complex as there is not one universal definition. Therefore, engagement has been extensively discussed in chapter 2, under the three dimensions of affect, behaviour and cognition (Fredricks, Blumenfeld, & Paris, 2004).

Manipulatives: “Manipulative materials are objects designed to represent explicitly and concretely mathematical ideas that are abstract… they can be manipulated by learners through hands-on experiences” (Moyer, 2001, pp.176). In the context of this research manipulatives refers to fine motor movements, and is not dependent upon purposeful movement (definition below). Purposeful movement occurs with or without the use of manipulatives.

Motivation: Motivation is strongly associated with engagement, however they are not the same. Motivation affects learning by directing it to a specific goal, therefore, it influences the energy, effort and persistence of students to achieve that goal (Attard, 2011). In turn, motivation is a huge contributor to engagement.

Physical movement/activity: In the context of the research study, physical movement was defined as “any bodily movement produced by skeletal muscles that require energy expenditure” (World Health Organisation, 2014, pp.1).

Purposeful movement: The researcher defined purposeful movement as movement which is integrated into classroom pedagogy to engage children and achieve learning outcomes.

Traditional teaching methods: Traditional teaching approaches are teacher-directed and follow specific steps of activities and demonstrations (Walls, 2005).

Research Question

In order to determine how purposeful movement was incorporated into mathematical lessons and if this incorporation increased student engagement, the following research question was established:

What effect does purposeful movement have on student engagement when undertaking mathematics?

The intention of the research question was to allow all participants (students and teacher) to voice their opinions regarding purposeful movement within mathematics. To answer the research question, qualitative data was gathered and analysed. The main assumption of this research was that a teacher within the selected school extensively used movement within his/her mathematics pedagogy. This assumption was based on the researcher's personal observations whilst on professional experience, as further discussed in this chapter.

Significance of the study

This research project holds personal significance from both a research and practical sense. My interest stems from my previous Professional Experience in 2014, where my colleague teacher effectively used movement throughout her lessons. The students were rarely seated at their desks and there was little use of worksheets. At first, this seemed unusual, as it was different to what I had seen in other classrooms and seemed far from the 'traditional' approach to teaching. It was not until I realised how much the students loved learning and were so eager to be involved that I realised how effective her teaching style was; this has altered my original teaching philosophy to incorporate more movement based activities in lessons. To arrive at an investigable research question I had many conversations with my nephews, Jack (age 7) and Tyler (age 4). I would ask them if they found learning fun and what made learning fun. They would often respond with scenarios that happened at school, which they enjoyed; more often than not these responses included movement. Jack, who was in Grade 1 at the time, was so excited to tell me how he learnt the time from using his body; he proceeded to show me on the floor, 6 o'clock, 3 o'clock and half past three. The excitement about his mathematical learning, reminded me of the beneficial strategies my colleague teacher used to implement purposeful movement into her teaching. This was a significant indicator to me, as I was commencing my research career, of what I was interested in and what would hold my curiosity for a research project. I was able to combine my passion for teaching mathematics and strong beliefs of the benefits of kinaesthetic learning to investigate whether this leads to increased student engagement.

This research sought to investigate how movement can be incorporated into mathematics pedagogy and what affect this has on student engagement. Significant to this educational research is the need for ongoing knowledge surrounding how to improve student engagement in mathematics. Students are disengaging with mathematics at a very young age (Larkin & Jorgensen, 2015). This should be a major concern for educators as there are a large number of students not choosing mathematics subjects at post-secondary or tertiary level (Attard, 2011). Educators are encouraged to implement pedagogical strategies, which are engaging for students (McPhan et al., 2008). Engagement itself is a complex, multi-faceted construct, which requires further research in terms of interventions in the classroom setting (Fredricks et al., 2004). However, studies have been conducted which demonstrate the potential of using purposeful movement to enhance learning and increase student engagement (Smith & Pellegrini, 2013; Speilmann, 2012; McGregor, Swabey & Pullen, 2015). Kraft (1990) suggested that kinaesthetic learning strategies are more effective at enhancing retention levels and engagement in primary school students, as they are actively involved in the process. Through the promotion of kinaesthetic learning, teachers are breaking the routine of students sitting while learning at school, and then sitting at home which is a common occurrence in today's society with the rapid advances in technology. Praag, Shubert, Zhao, and Gage (2005) stated that large-muscle movements cause neurotransmitter release, which encourages neuronal growth in the hippocampus. Located in the brain, the hippocampus is an essential part of the growth and development of an individual's short and long-term memory, as well as it being a key aspect of emotions and spatial navigation. However, increased brain cells from neuronal growth are not known to make individuals more intelligent, but it does give a higher capacity for them to learn (Praag et al., 2005). This suggests the need for and benefits associated with physical activity and its purposeful inclusion in the classroom. However, very few studies have been conducted concerning the impact on student engagement through the incorporation of purposeful movement into mathematical activities. Wood (2008) suggested that movement offers an active learning strategy that requires few resources, to achieve a variety of outcomes across mathematics domains. Wood's (2008) focus was on dance and how she used this to increase engagement in mathematics in a remote area in Western Australia. The findings of the current study being undertaken could add to the research base and offer evidence-based recommendations for effective practice in mathematics, thus justifying the significance of this research. The results from this study will inform classroom teachers of the effect of movement on student engagement within mathematics lessons, which is significant, considering the rapid decline in engagement in mathematics.

Chapter Summary

This chapter outlined the background, the aims, and the definition of terms in the context of the research. The chapter discussed the significance of this research both personally and in the context of the literature, documenting the need for more knowledge and understanding surrounding young students' engagement in mathematics. The following chapter outlines the literature relating to student engagement in mathematics and the benefits of the inclusion of movement in the classroom.

Chapter 2

Literature Review

There are three main focuses of this literature review. The first explains the benefits of movement to student learning, the second presents literature on effective mathematics teaching, and the third defines engagement and discusses an underlying theoretical framework, which provided a tool to measure engagement within this study. These three areas inform the context for the study and include a critique of studies undertaken in the past surrounding this topic, indicating a gap in the literature.

Benefits of Movement to Student Learning

There is extensive literature on the benefits of movement on children's health and psychological wellbeing, but limited research surrounding the impact of movement on student learning in the classroom (Tomporowski, Davis, Miller, & Naglieri, 2008).

Movement has traditionally held its place in the school day during recess, lunch and throughout specific physical education classes. Despite this, there is growing research, which suggests movement should be incorporated into the classroom itself (Cleary, 2012). In terms of movement within the classroom, one particular study by Cleary investigated the effect of five-minute movement breaks on student learning. The study was conducted in a Grade 5 classroom and reached the conclusion that by implementing a five-minute movement 'break' within lessons there are positive effects on students' engagement and attention (Cleary, 2012). However, the focus of Cleary's study was different to that of the current study, as it did not investigate the impact of implementing movement that contributed to learning within mathematical pedagogy and lesson sequences. Similarly, research has been conducted with year 8 students where the data showed positive benefits of including movement within the classroom (Wells, 2012). By incorporating movement in classroom activities there was a significant decrease in off-task behaviour and an increase in engagement. Nevertheless, it was also noted that further study is necessary to determine how to achieve an increase in student achievement (Wells, 2012). Research into this topic has shown a positive connection between movement and learning (Wells, 2012). Although the above studies provide some evidence of the benefits of movement on student learning, they do not investigate the attitudes and perceptions of the students'. Research detailing both the benefits of movement on engagement within mathematics, as well as student perceptions, was unable to be sourced due to the limited volume within that particular field.

Researchers have discovered many benefits of active learning and its process of engaging the students' heart, soul and mind to create an authentic learning experience rather than passively teaching knowledge (Mahmood, Tariq, & Javed, 2011). Passive teaching methods may not provide students with significant skills or even the knowledge to last much beyond the end of the term (Udovic, Morris, Dickman, Postlethwait, & Wetherwax, 2002).

Much of the research conducted to date demonstrates the potential of using purposeful movement to enhance learning (Smith & Pellegrini, 2013; Speilmann, 2012). Kraft (1990) suggested that kinaesthetic learning strategies are more effective at enhancing retention levels and engagement in primary school students, as they are actively involved in the process. Through the promotion of kinaesthetic learning, teachers are breaking the routine of students sitting while learning at school. Lengel and Kuczala (2010) stated that engagement and enthusiasm are natural by-products of kinaesthetic classroom learning. Additionally, they discussed how movement in the classroom benefits the learning process by preparing the brain for better retention and retrieval of information.

Praag et al. (2005) stated that large-muscle movements cause neurotransmitter release, which encourages neuronal growth in the hippocampus. An increase in the amount of brain cells (from neuronal growth) gives a higher capacity for students to learn (Praag et al., 2005). This suggests the need for and benefits associated with physical activity and its purposeful inclusion in the classroom. Despite this, only very few studies have investigated the impact on student engagement through the incorporation of purposeful movement into mathematical activities.

Additionally, researchers have found many benefits of movement and its incorporation into children's lives. Kamii and Rummelsburg (2008) stated, "children who are mentally active develop faster than those who are passive" (p. 393). Furthermore, it has been stated that young children require physical activity that is developmentally appropriate to ensure benefits in skeletal health, strength and fitness (Strong et al., 2005). With this in mind, the current research study will go further by specifically looking at the effects of movement on mathematics education. Movement has been proven to be an important method of enhancing aspects of children's mental functioning (Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Tomporowski et al., 2008). The researcher has chosen to look at movement within mathematics because unfortunately mathematics is often a subject that is associated with disengagement.

Mathematics Education

Many students fail to enjoy or see the relevance of mathematics, which is concerning as fewer students are voluntarily choosing to continue to study it in the later years of secondary school (Sullivan & McDonough, 2007, cited in Attard, 2011; McPhann et al., 2008). Although, it is possible to change attitudes throughout school years, once negative attitudes are formed they are very difficult to alter (Attard, 2011). Through disengagement in mathematics in the early years of schooling, students' capacity to understand life experience through a mathematical lens is limited (Sullivan, Mousley, & Zevenbergen, 2005). Arguably, one of the most influential factors impacting on student engagement in mathematics is the pedagogy adopted by the teacher (Hayes, Mills, Christie, & Lingard, 2006; Fredricks et al., 2004). Hargreaves (1994, cited in Attard, 2009) claimed that the learning of young people is ultimately shaped by what the teachers do at a classroom level to develop, define and reinterpret the curriculum.

The use of manipulatives has been studied for many years, both internationally and nationally. Early research undertaken in the 1960s and 1970s, and followed up in research by Moyer (2001) has shown that students who use manipulatives during mathematics instruction outperform those who do not. The benefits associated with the use of manipulatives is often from the opportunity to provide hands-on learning experiences (Moyer, 2001). This is associated with fine-motor movements, because with most manipulatives students are usually required to be tactile with the materials. However, there is little research surrounding how mathematical concepts can be learnt through incorporating kinaesthetic learning and large-whole body movements. Wood (2008) described how she used dance to engage students in mathematical investigations in a remote setting in Western Australia. She found that she was able to achieve a variety of learning outcomes across the mathematics domains through the incorporation of dance (for example, looking at fractions when dancing). However, there seems to be a gap in the literature when it comes to recognising young students' voices and their perceptions on quality teaching in mathematics learning. It could be argued that students' as young as six would have trouble recognising what they truly enjoy. Conversely, if engagement is a student's response to their experiences, their beliefs should be heard in order to help inform high quality-teaching pedagogies and frameworks.

Defining and Measuring Engagement

Research on student engagement is extensive and complex. Due to this complexity, researchers differ in opinions of what engagement involves, how it can be measured and what factors combine to result in engagement. Fredricks et al. (2004) described student engagement as a highly complex and multi-faceted construct; a fusion of dimensions of behaviour, emotion (sometimes labelled 'affective' in other studies) and cognition. Most research surrounding engagement acknowledges these commonly identified dimensions.

Behavioural engagement is commonly defined in three ways (Fredricks et al., 2004). Firstly, it encompasses students' positive conduct, such as following rules and adhering to the norms of the classroom (which in turn involves the absence of disruptive behaviours) (Fredricks et al., 2004). Secondly, behavioural engagement involves the participation in learning, which reflects on behaviours of persistence, concentration, attention, asking questions and contributing to class discussion (Fredricks et al., 2004). Thirdly, it involves school-related activities (Finn et al., 1995, cited in Fredricks et al., 2004; Finn, 1989). In summary, Kong, Wong and Lam (2003) identified three dimensions of behavioural engagement; attentiveness, diligence and time spent on mathematical learning outside of class time, with all three definitions being previously discussed.

Emotional engagement, or affective engagement as it is often referred to (affective will be the term used for the purposes of this study), encompasses the beliefs, attitudes and emotions experienced by students (Fredricks et al., 2004). Researchers have evaluated affective engagement by measuring students' emotional reactions to school and the teacher (Stipek, 2002, cited in Fredricks et al., 2004). Aspects of affective engagement are widespread, with some areas recognised as anxiety, interest, boredom, achievement orientation, frustration, identification with teachers or peers, a sense of belonging and being valued in schools (Kong et al., 2003; Fredricks et al., 2004; Finn, 1989).

Cognitive engagement is complex, with research suggesting it encompasses the importance of an investment in learning and self-regulation and being strategic (Fredricks et al., 2004). Connell and Wellborn's research (1991, cited in Fredricks et al., 2004) focuses on the psychological investment of learning and having a desire to go beyond what is required. There is a distinction in cognitive engagement between students' using deep strategies, such as integration, and surface strategies, where students rely on memorisation (Kong et al., 2003).

It is important to provide an in-depth discussion into the dimensions of engagement as it recognises the inter-relatedness of each of the dimensions (Fredricks et al., 2004). This is especially relevant to this study, for example, when purposeful movement is included, students may be disruptive and not following the classroom rules, giving the impression of behavioural disengagement. However, they may in fact be deeply affectively and cognitively engaged in the content but just 'acting out' due to excitement. Additionally, it is important to recognise each dimension of engagement as this gives a holistic approach toward the measurement of a student's level of engagement. Noticeably, it is not possible to say a student is engaged or disengaged without taking into consideration each dimension of engagement.

In order to see if purposeful movement has an effect on student engagement in this study, Kong et al.'s (2003) framework has been utilised to investigate and interpret student perceptions. This framework outlines significant markers under each of the three dimensions of engagement (see Figure 2.1).

Affective:

- Interest
- Anxiety
- Frustration
- Achievement orientation

Cognitive:

- Deep strategies
- Surface strategies
- Reliance

Behavioural:

- Diligence
- Attentiveness
- Non-assigned time on task

Figure 1.1. Kong et al.'s (2003) dimensions of engagement

Motivation and Engagement

It is important to distinguish the difference between motivation and engagement, as often these terms are confused as the same; although they are related, they are distinct from each other. Motivation can enhance cognitive processing and leads to improved performance (Ormrod, 2005). Motivation affects learning and behaviour by directing it to a particular goal, which leads to increased energy and effort (Attard, 2012). Therefore, engagement and motivation are strongly inter-related, that is, motivation is the reason for student engagement (Attard, 2012).

Students’ motivations will determine whether an individual will engage with a particular pursuit (Attard, 2012).

A desire to achieve is one motivator of achievement orientation, which is outlined as one of Kong et al.’s dimensions of engagement. Weiner’s (1985; cited in Latu, 2004) attribution theory encompasses how individuals interpret events and how this relates to their thinking and behaviour. He suggests three dimensions for accounting for an individual’s success or failure:

- Locus of control- external versus internal
- Stability- stable versus unstable
- Controllability- controllable versus uncontrollable.

Weiner (1985; cited in Latu, 2004, pp. 344) states, “the stability dimension is most closely related to expectancy for success. Esteem related affects are related to the locus dimension, and social related affects are related to the controllability dimensions.” These dimensions tie with extrinsic and intrinsic motivation. Extrinsic motivation in this case is the desire to achieve good grades; this could be heightened if the student’s knowledge of results and success is given (Benabou & Tirole, 2003; Deci & Ryan, 1985). Alternatively, intrinsic motivation is internal, where the student has a true desire to learn (Benabou & Tirole, 2003; Deci & Ryan, 1985). Those who generally attribute their success or failure to their own behaviour imply an internal locus of control, however those who attribute their success or failure to luck or difficulty imply to have an external locus of control (Latu, 2004).

Chapter Summary

As reviewed throughout this chapter, there is extensive research in the areas of movement, mathematics education and engagement. However, there was no research found that linked these three domains together, signifying a gap in the literature. One of the core influences of student engagement is ultimately shaped by what teachers do at the classroom level, how they develop, reinterpret and deliver the curriculum (Hargreaves, 1994, cited in Attard, 2009). The influence of effective teaching strategies provides a link to purposeful movement being a possible pedagogical repertoire to tap into improved student engagement.

As previously stated, there have been many studies conducted on the inclusion of movement within the classroom but there was no literature found with regards to improving engagement in mathematics education through the use of whole-body, purposeful movement. The studies that have been conducted focus more on older students and how to improve attention and engagement in general, not in a specific curriculum area as this study does.

The following chapter describes the methodological approach used in the study, including details about the participants, procedures, instruments and data analysis.

Chapter 3

Methodology

Chapter Introduction

This chapter outlines the design of the research project. It begins with a discussion about the methodological framework, outlining the qualitative methods utilised. Details are provided about the participants and the reasons behind their selection for this study. The recruitment process and ethical considerations underpinning this research are then detailed to demonstrate how they were addressed. Finally, data collection procedures and analysis methods are discussed.

Context

A Catholic primary school in Northern Tasmania was the school in which the research study was undertaken. The research was conducted over a three-week period in which eight mathematics lessons were observed and analysed in a grade 1 classroom. The mathematics lessons ran for approximately one and a half to two hours between 11:30am to approximately 1pm or 1:30pm.

Timeframe

To ensure the research was conducted within the allocated time, a Gantt chart was devised (see Figure 3.1.). The timeline was flexible to allow for unexpected hurdles and delays.

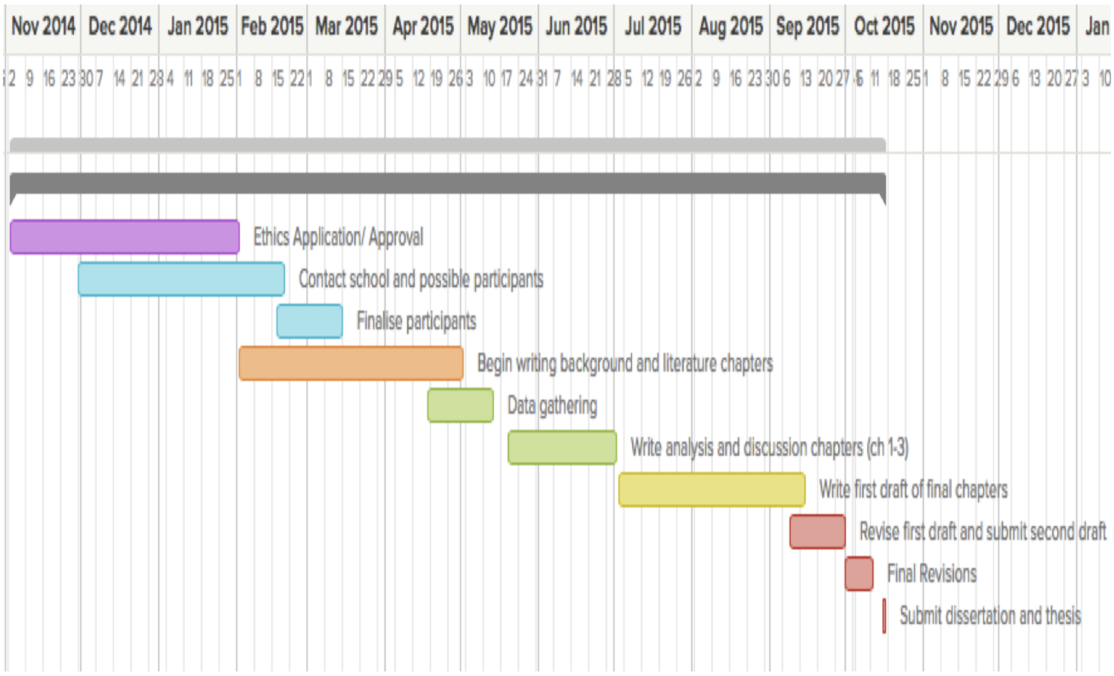

Figure 3.1. Timeline for completion

Methodological Framework

The philosophical worldwide view of social constructivism has shaped the qualitative approach to research. The constructivist worldview encompasses research to rely as much as possible on the participants' views of what is being studied (Creswell, 2014). In fact, this view involves recognising social constructionists who accept the ontological assumption associated with constructivism, which is socially constructed and time and context dependent (Mertens, 2010). The interpretivist paradigm was followed in this research study, where the emphasis is on the individual to construct meaning (Mack, 2010). This paradigm is heavily influenced by phenomenology, where there is a need to consider human beings' subjective interpretations and their perceptions of the world as a starting point in understanding social phenomena (Ernest, 1994; Mertens, 2010). The intent is to understand and describe a lived event from the point of view of those who lived it (the participants of the study) (Mertens, 2010).

Therefore this paradigm was used to uncover students' and teacher's perceptions of purposeful movement to determine if there was a link between purposeful movement and increased levels of engagement in mathematics.

The research question was answered using a case study inquiry (Stake, 1978). This is a qualitative research approach, in which the researcher developed an in-depth analysis of a case (in this situation mathematical pedagogy with the inclusion of purposeful movement) (Creswell, 2014). Additionally, through focusing on a case the researcher reached an understanding within a complex context (Mertens, 2010). Cases are bounded by time and activities (O'Leary, 2010; Stake, 1978). Case studies provided the researcher with an opportunity to collect detailed information in a timely manner using a variety of data collection procedures (Creswell, 2014; Stake, 1978).

In this research study the data was collected through classroom observations, interviews with the teacher and examinations of student video diaries. Hence, there was a need to limit the sample size to one class. Qualitative research requires a much smaller sample size than quantitative research, primarily because qualitative work is much more resource intensive and the analysis requires a more in-depth approach (Creswell, 2014). This type of research presents an insider's perspective, which uses descriptions rather than numbers to understand the occurrences (Creswell, 2014). Therefore, when answering this research question it was considered more suitable to implement qualitative approaches.

Participants

Using purposive sampling the researcher invited the teacher she had on Professional Experience in 2014 to participate in the study. The teacher was selected because she made use of purposeful movement within the classroom to engage students in authentic learning experiences. She was currently teaching a grade 1 class of 28 students. Due to the nature of the study, it was necessary to purposively select the teacher and class in order to observe the effects of purposeful movement.

The teacher and all students in the potential subject group were invited to take part in the study. They were informed that both they and their parents would need to give consent if they wished to participate. It was reiterated that their participation was voluntary and they could withdraw at any time from the study. In total, the teacher and 22 out of 28 students (79%) returned signed permission forms. No participants chose to withdraw from the study.

Data Instruments

Data instruments included audio-recorded interviews with the teacher, observations of lessons and individual student video diaries. A pre interview was conducted prior to any observation of lessons. The pre interview was an important data instrument as it enabled the participating teacher to shape and develop the meaning of the study (Creswell, 2014). Following each observed lesson, the researcher interviewed the teacher in a face-to-face format. Whilst these are referred to as interviews, they were set up to be a post lesson discussion using open-ended questions to stimulate conversation (Appendix A). The open-ended questions were an instrument relevant to an interpretivist paradigm and a qualitative research study, in order to uncover the nature of the perspectives of the interviewee (Creswell, 2014).

Classroom observations were unobtrusive and the students knew why the researcher was there. Data collected throughout the lesson observations were in the form of field notes. The researcher observed the students' active participation in the lesson, the opportunities they had to be physically active and the types of activities they undertook, enabling the researcher to have firsthand experiences with the participants (Creswell, 2014). An observation pro-forma was used to record these observations (Appendix B). The pro-forma contained details of the lesson activities, student engagement (looking for a combination of affective, behavioural and cognitive behaviour), teacher-student interactions and student-teacher interactions. Following each observation session, the researcher added further description of what happened in the lesson, and noted interesting occurrences from the lesson and student discussion. This pro-forma was piloted twice to ensure the instrument was appropriate for the researcher, as explained further in this chapter.

Student video diaries were an important instrument for this research, and allowed students' to respond openly to prompts created by the researcher (Appendix C). Video diaries produce 'honest' responses as the power between the adult and child is minimised so the child does not feel obliged to please the adult (Larkin & Jorgensen, 2014). This was an enjoyable and novel experience for young children who would not normally be interested in writing or answering surveys and interview questions, thus receiving data that is more profound and compelling in quality (Buchwald, Schantz-Laursen & Delmar, 2009). It is known that using video diaries enables the students to be the central agents in the data collection process, speaking authentically of their own experiences (Larkin & Jorgensen, 2014). This data gathering procedure has been used elsewhere and was documented to be a successful method in collecting data about young children's perspectives and attitudes towards mathematics (Larkin & Jorgensen, 2014).

Triangulation is using more than one source of data to confirm authenticity of each source (O'Leary, 2010; Lambert, 2012). Triangulation is a relevant technique, as a single qualitative method cannot adequately shed light on social phenomenon. Through the use of multiple methods the researcher developed a deeper understanding of the participants viewpoints (O'Leary, 2010; Lambert, 2012). The use of field notes, student video diaries and teacher interviews, enabled a triangulation of results which goes beyond the knowledge identified by one data source, thus promoting quality in research (Flick, 2009).

Procedures

Following the attainment of ethical approval form *Human Resource Ethics Committee [HREC]* and formal permission from the principal, teacher, students and parents (Appendix D, E, F, G, H and I respectively) the data collection took place in the last three weeks of term two. Data gathering ceased when fresh data no longer sparked new properties, adopting the saturation strategy (Charmaz, 2006; O'Leary, 2010). Students were reminded in this time that their participation was voluntary and they had the option to withdraw from the study at any time.

Firstly, a pre interview took place in a private area nominated by the teacher. The interview was semi-structured and took approximately five minutes. Classroom observations were recorded in the form of field notes; this took place in all eight lessons. Observation field notes firstly provided a summary of the lesson, of student engagement in response to purposeful movement, teacher-student interactions and student-teacher interactions. The field notes then provided detailed information about the lesson, including any interesting occurrences and student conversations or comments.

The video diaries were recorded directly after every mathematics lesson. After each lesson some students were invited to individually respond to four prompts about the lesson they just experienced (Appendix C). Again, each student's participation was voluntary and they had the option to decline the invitation to record themselves. The responses were recorded on an iPad supplied by the researcher. Students who had given consent recorded themselves more than once across the duration of the study. The selection of the students to participate after each lesson was rotated to ensure that there was a fairly even distribution of student perceptions. The students took the iPad to a quiet area and recorded themselves individually. However, there were some exceptions where the researcher read the prompts out to students when necessary. Students were able to ask questions at any time.

At the conclusion of every mathematics lesson the researcher had a post discussion with the teacher, asking the same open-ended questions (Appendix A). This took approximately five minutes and occurred at lunchtime in a private area nominated by the teacher. The audio file of the post-class discussion was recorded on an iPad with the participating teacher's permission. The participant was aware that the transcripts from the post discussion were available for review, however, no re-recording of the post discussion or amendments to transcripts occurred. All names referred to in audio recordings were replaced with pseudonyms for transcribing and publishing purposes. This uncovered the teacher's perceptions and allowed her to provide her point of view without being subject to bias (Creswell, 2014). Interaction with both teacher and students and also observations of teacher and students was necessary in order to identify whether there was a link between purposeful movement in mathematics and increased student engagement.

Data Analysis

The data used in this project included student video recordings, teacher audio recordings and classroom observations. The video and audio recordings were played back initially to develop an overall sense of the data and identify salient moments/comments in the data that required transcription in full for deeper analysis. The transcripts were coded by the researcher using thematic analysis to uncover common themes in the participants' intrinsic beliefs and perceptions (Mills, Durepos & Wiebe, 2010). The Kong et al. (2003) framework for engagement was used to provide the categories when thematically analysing the participating teacher and students' comments. Specifically, the framework was used to conceptualise and measure engagement in mathematics, using significant markers of engagement, which are as follows:

Affective engagement

- Interest (find learning enjoyable, interesting, excited, like, satisfaction)
- Anxiety (nervous, worried, afraid, anxious)
- Frustration (dislike, difficulty, boredom and 'tiredness')
- Achievement orientation (desire to succeed, focus on good results)

Behavioural engagement

- Diligence (effort, persistence)
- Attentiveness (concentration, active participation)

- Non-assignment time spent of task (voluntary time spent on tasks outside of class time)

Cognitive engagement

- Deep strategies (understanding, making connections, justifying)
- Surface strategies (memorisation, practising)
- Reliance (on others- teachers, peers, parents)

The researcher additionally used open coding for data that did not fit under the categories set out by Kong et al. (2003). Open coding focused on the abstraction of potential core concepts or core variables (Flick, 2009; Saldaña, 2012). This allowed the researcher to be open to unanticipated responses, which can enable the development of new theory. The analysis and development of the theory aims to discover patterns in the data (Flick, 2009). On analysis of the open codes the researcher added a category under cognitive engagement, *acknowledgment of mathematics content*, to this framework under the dimension cognitive engagement. Several comments were made by students in reference to what they had learnt, however it was unable to be coded under the use of ‘deep’ or ‘surface’ strategies because they were referring to content knowledge rather than strategies as such. Therefore, the addition of a new category was necessary. This is further discussed within Chapter 5, Results and Discussion.

In order to determine coder reliability, a random selection of 10% of transcripts were coded independently by two raters, both of whom were familiar with the Kong et al. (2003) scale. On comparison there was a 94.7% inter-rater reliability between the two raters.

Ethical Considerations

The implementation of clear ethical procedures is essential to ensure the participants felt comfortable in what they were involved in and why (Bourke & Loveridge, 2014). This study did not put any stress on the student, as the classroom activity was part of their normal daily routine. However, if students felt anxious or upset when recording themselves, they had the option to withdraw from the study and their data was not analysed.

The identity of the participants was protected and care was taken not to include any identifying information about the participating teacher when writing the results. Students' names were not included in interview transcripts; instead their names were replaced with pseudonyms. Following the transcribing of the individual video recordings, all digital files were deleted. Hard copies of students' video recording transcripts and audio recordings from the teacher interviews will be stored securely at the University of Tasmania. As the study involved only one participating teacher, it is possible that she could be identified by the school community; however this was outlined in the teacher information sheet and consent form.

Reliability and Validity

Qualitative validity means that the researcher uses multiple strategies to enhance their ability to assess the accuracy of the findings (Creswell, 2014). Separately, qualitative reliability indicates that the researcher's approach provides consistent results (Creswell, 2014; Lambert, 2012). Within this study multiple techniques have been put in place to strengthen the reliability and validity of the study.

It is impossible to achieve complete reliability and validity in research, as there are far too many influential factors (Lambert, 2012).

To support the reliability of the study, two pilots were undertaken before commencing the data gathering procedure. This was a means of testing the research instruments and making amendments as a result (Lambert, 2012). The first observation pro-forma was not successful due to the limited space it provided to make field notes so amendments were made to improve the researcher’s approach. The second pilot proved the research instruments to be successful and allowed for more observations to be noted.

To enhance the reliability of the research, codes were crosschecked individually by two different researchers and then compared. This comparison showed a 94.7% inter-rater reliability, as mentioned above, in relation to data analysis.

Limitations

Through implementing a qualitative approach to the research, data gathering techniques created some limitations to the study. There are many advantages to using observations, however in some instances the researcher may be seen as intrusive and private information may be observed that researchers cannot report (Creswell, 2014). When interviewing the teacher, the researcher’s presence may bias responses and it provides indirect information filtered through the views of interviewees (Creswell, 2014). Additionally, only one class was studied, therefore only one school was researched, with one particular demographic of students, at one point in time. Due to the embedded honours time constraints, encompassing a broader range of participants from differing socio-economic areas and different year levels was not possible.

Therefore, due to the small sample size the results are not representative of the population. However, the study does have practical implications and will offer evidence-based recommendations for effective mathematical activities that involve movement that may be generalizable to a wider population.

Chapter Summary

This chapter outlined the design of the study. The selection of the participants was discussed and the reasons for using purposeful sampling were justified. The methodological framework was discussed in light of the qualitative methods used to collect and analyse the data. The results that were uncovered using the methods discussed are presented in the following chapter.

Chapter 4

Results and Discussion

Chapter Introduction

This chapter presents the results and discussion together. These have been combined to ensure clarity of the findings and to avoid duplication of information. In compliance with the ethical guidelines for this research, the participants' names have been omitted and the participating teacher is referred to as Miss O. Students are referred to by a gender-matched pseudonym, using a random name generator.

The structure of this chapter provides a context for the study, identifying Miss O's perceptions and an illustration of a sample of lessons that were observed. The results of the study are then presented, along with supporting discussion under the dimensions of engagement outlined by Kong et al. (2003). An additional category, acknowledgment of mathematical content, outlined by the researcher is then presented centred on the results from the study.

Pre-Interview

The purpose of the pre-interview with Miss O was to set the context for the case study, highlighting the teacher's structure for her mathematics lessons.
In the pre-interview for the study Miss O highlighted her structure for the incorporation of movement into mathematics lessons. Miss O defined purposeful movement as:

> *any type of bodily movement because movement makes students engaged… and you get better learning retention if they [students] are engaged. I think*

it's where students are actively engaged in the lesson through some kind of movement… it has to be physical though. I definitely think that purposeful movement is more about how you engage students in learning, by making it more active it makes it fun.

When asked about purposeful movement, Miss O described it in terms of her pedagogical purpose; that is, to integrate movement into classroom activities and lessons to ensure students engage with intended mathematical learning outcomes. To illustrate, she provided examples of the types of purposeful movement that she included in her pedagogy, which contributed to her definition of purposeful movement:

-*They were interacting in an actual number line so that was purposeful movement by getting up and seeing how the number line worked.*
-*Leapfrog… The green leaves represent frog lily pads and so they [students] are moving from one to the next.*
-*The graphing because it's a manipulative activity involving purposeful movement… as they were able to construct it themselves.*

The construction of the graph involved students working together as a small group to make a column graph on the ground, using masking tape for the x axis and y axis and labels and coloured paper to make the columns in the graph of students' favourite colours.

The examples Miss O gave in regards to purposeful movement, suggested that she was referring to purposeful movement as large muscle, whole-body movement and fine-motor movement. Another theme that became apparent through discussions with Miss O, was that of increasing student engagement with mathematics. She often commented on the level of student engagement in a lesson:

Interviewer: How would you rate the level of engagement from students in your activity?

Miss O: High, they enjoyed it… I just don't think they understand it.

However, it is important to note that Miss O also considered the development of students' mathematical understandings:

Interviewer: Did the lessons achieve its objectives?

Miss O: No, it didn't because some do not understand.

Here Miss O was able to acknowledge high affect but low cognition within this lesson. Additionally, she supports cognition with her intent of using purposeful movement to teach the use of deep strategies:

So the subtraction activity was counting back and initially it was meant to be outside moving, jumping back but we did it inside with cups [due to weather].

This is supported by student comments on what they learnt. Within this lesson three out of six students noted how they learnt the counting back strategy and how it helps with subtraction, which is further discussed in this chapter. This shows a relationship with the effectiveness of this pedagogy to teach deep learning strategies within mathematics.

Miss O explained how she incorporates movement into her mathematics pedagogy. Her response,

> *it is my mathematics pedagogy…pedagogy is essentially the way that you approach teaching and mine's very kinaesthetic based which is how the movement is incorporated, providing hands on learning experiences.*

This highlights her extensive use of movement within her pedagogy, which aligned with what was observed by the researcher. This comment encapsulates the definition of purposeful movement made by the researcher, referring to the benefits of kinaesthetic learning. The researcher noted that incidental movement, for example, moving between groups, was evident in all lessons. However purposeful movement, which was integrated into the teacher's pedagogy, was observed in seven of the eight lessons, and was absent in the final lesson. The researcher requested this absence, to act as a control lesson to regulate any major differences between student responses to the incorporation of movement.

Miss O gave reasons for why she includes movement in mathematics, in her comments:

By incorporating movement you are able to engage a larger variety of learners and differentiate a little easier than if you just gave a student the same worksheet.

A key element of her justification for purposeful movement was the ability to engage a variety of learners and that purposeful movement makes it easier for her to differentiate. This was also noted in the observations made by the researcher. Within the rotational group led by the teacher, she was able to give different experiences tailored to students' needs. However, the relationship between differentiation and purposeful movement was not the focus of this study and will need further research to determine its effectiveness.

Context

This section presents an illustration of a sample of two lessons that were observed by the researcher. This provides an insight into the structure of the lessons and gives examples of how Miss O incorporated purposeful movement within her pedagogy. As observed by the researcher, each lesson was structured similarly. Students were seated on the floor in a circle to receive the lesson instructions and then would divide into three rotational groups, each lasting for approximately fifteen minutes. At the conclusion of each lesson students returned to the mat, seated in a circle for a class reflection.

Lesson 6

The focus of lesson 6 was identifying place value within two, three and four digit numbers. The students were divided into three rotational groups and all three groups had the same focus. Rotational group one included MAB blocks[1] where students wrote a two or three-digit number on a whiteboard then their partner made this number using MAB blocks.

Rotational group two worked with the teacher's aide. Students, with the help of the teacher's aide, wrote three digit numbers down and talked about hundreds, tens and ones. Once each student had formed a number and discussed it, they played hangman with the three digit numbers. Clues were given to help students guess the numbers; for example, in my ones column the digit is even.

Rotational group three was with Miss O. Four pieces of paper were placed on the ground, with TH (Thousands) H (Hundreds) T (Tens) O (Ones). See Figure 4.1. for a visual representation.

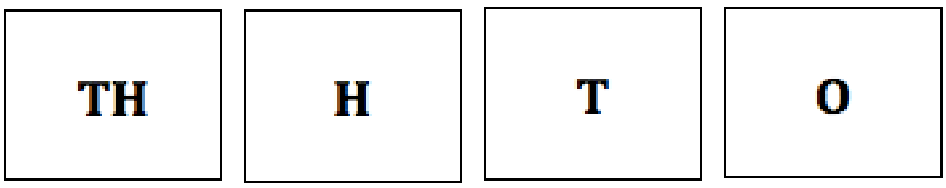

Figure 4.1. Representation of station set up by the participating teacher

The teacher called out a number and students wrote this number on their individual whiteboard. Then one student jumped on the pieces of paper to represent the number; for example, 532, the student jumped five times on the H (Hundreds), three times on the T (Tens), and two times on the O (Ones). This occurred a number

[1] MAB stands for Multi-base Arithmetic Blocks.

of times with different three-digit and four-digit numbers. A game of bingo was then played using three-digit numbers. All students had a pre-determined bingo card and the teacher would randomly select the numbers. The first student to have four numbers covered in a row called bingo. The lesson finished with a whole class reflection where students were seated on the mat, and were asked about what they had learnt.

Lesson 8

The final lesson that was observed (Lesson 8) had a learning intention of solving three-part and two-part addition number sentences using different strategies. The students were divided into three groups using no specific identified criteria and all groups experienced three rotations. The rotations included a worksheet (with the teacher) that had thirty two-part and three-part number sentences that needed to be solved. There were two worksheets; the ‘easier’ option, which had two-part number sentences, and the ‘harder’ option, which had three-part number sentences. The students were able to choose which one they wanted to do.

The second rotation used ‘bones’ which is a resource that has all elements of an addition or subtraction number sentence except one part, which is covered. The students were required to work out the missing part of the number sentence before checking their answer on the bone. The bones include both single digit and two digit numbers.

The third rotation was playing a mathematics App on the iPad of the students’ choice but limited to a selection of addition and subtraction related Apps pre-determined by Miss O. All groups had 15 minutes at each rotation. The lesson finished with a reflection, answering the key reflection question; *what did you learn* *in mathematics today?* Students responded to the reflection, expressing their ability to solve difficult number sentences using counting on and partitioning strategies.

Lesson Analysis

The data from the interview, student diaries and observations, form the basis for the discussion and analysis of the results. Codes were assigned according to Kong et al.'s (2003) structure and were organised according to the dimensions of engagement as discussed in Chapter Three, using student comments to further illustrate each dimension. A results frequency has been developed, documenting students' comments relating to Kong et al.'s dimensions of engagement, see Table 4.1. It is interesting to note the consistency across all levels of affect in positive forms. In lessons 1 to 6 students positively referred to affect seven or eight times, suggesting a high affect in mathematics lessons that included purposeful movement. Within lesson 7 students referred to positive affect fifteen times, with the increase from previous lessons due to more student video diary entries. This occurred because more students requested a turn at the conclusion of the lesson.

Table 4.1.

Results frequency of student comments from video diaries.

Category	**Lesson number**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Number of students who participated in video diaries per lesson.	**5**	**6**	**6**	**6**	**6**	**5**	**9**	**7**
Interest	7	7	7	7	7	8	14	5
Anxiety	0	0	0	0	0	0	0	0
Frustration	0	0	0	0	0	0	0	4
Achievement Orientation	1	0	0	1	0	0	1	0
Diligence	0	0	1	0	2	0	0	0
Attentiveness	0	0	0	0	0	0	0	0
Deep Strategy	0	0	0	1	6	1	0	0
Surface Strategy	0	0	0	0	0	0	0	3
Reliance	1	0	1	1	3	2	1	1
Total Engagement								
Affect- positive	8	7	7	8	7	8	15	5
Affect- negative	0	0	0	0	0	0	0	4
Behavioural	0	0	1	0	2	0	0	0
Cognitive	1	0	1	2	9	3	1	4

Affective Engagement

Affective engagement refers to the beliefs, attitudes and emotions experienced by students (Fredricks et al., 2004). The aspects of affective engagement, which were explored in this study, include interest, anxiety, frustration and achievement orientation (Kong et al., 2003).

Movement

One aspect, which repeatedly arose during discussions with the students, was that of affective engagement through movement itself. The consistently high mention of interest in this context by students occurred across the majority of lessons (1-7). Many students made mention of or reference to whole-body movements, such as running and jumping, as being an enjoyable means of learning mathematics.

Tim: *I liked doing baseball with Miss O.*

Baseball was a game set up by the teacher to teach the students fact families. The students had to roll the dice, using these numbers to form their number sentence. They then went around each of the four 'bases' writing their fact family on the whiteboard.

This emerging interest in learning when movement is present is confirmed in Attard's (2009) report, when she states that most of the lessons or activities that were recognised as 'fun' by students included active learning situations.

Interest

The results of data collected on the interest levels of students (Table 4.1.), indicates a very high level of interest in mathematics lessons with purposeful movement. The students reported high levels of interest across nearly all mathematics lessons, referring to it fifty-nine times. The lowest ranking lesson for student interest was lesson 8.

Comments provided by students were widespread with a number of students simply acknowledging their enjoyment of mathematics learning in their comments:

Lila: *I liked this because it was really fun.*

Emma: *Graphing makes learning fun.*

Georgia: *The activity I liked the most was using the money and counting them up.*

Tim: *Bingo is not really just a game to have fun it's a game to learn.*

Due to the high number of responses indicating student interest, the researcher included three sub-categories: real-life, self/ego-centric and student choice/empowerment. These three sub-categories were developed through open coding in the analysis stage of the research.

Real-life:

Many students' made comments referring to mathematics being interesting when it related to real life. Within this lesson the students were learning about and identifying Australian coins. The rotational station with Miss O was set up to mimic a shop where some students were the ‘shoppers’ and others were the ‘shopkeepers’. The shoppers were required to buy items with their coins and the shopkeepers would check if they had been given the correct amount.

Georgia: *I liked this because it was fun doing the shopping.*

Nathan: *I liked it because it was fun and I got to learn about money.*

Caleb: *I learnt that money can help you buy things…and I liked it because it was fun.*

These students could see the connections between learning about Australian coins and real-life. Kong et al. (2003) indicated in their study that real-life experiences have a positive relationship with high affective engagement. In this study, each student related this mathematical learning to shopping or being able to buy things, which is likely to be a common association with their life outside of school. The aspect of interest and ‘fun’ was evident in these comments, suggesting a link between high interest and real-life situations, which is consistent with the findings of Attard (2009).

Self/ego centric:

There were many statements where students referred to an increase in interest when the mathematics learning involved them. This suggested that students enjoyed learning mathematics when it involved them or they were good at it, which is very common for students at this age. The comments below were coded under the sub-category self/ego-centric, and occurred across a number of lessons that were observed.

April: *…the job I liked best because I was very good at Miss O's.*

Nick: *I liked it when it was my go.*

Tim: *I liked this because I got to be the first one to do it.*

Tim: *We got the right number sentences and I beat [student].*

In looking at the students' comments that can be assigned to the affective engagement criteria of self/ego-centric the students reported high interest when the activity involved them. Purposeful movement provided greater opportunities to involve the participating students in the mathematics learning. According to Piaget's (1970) stages of development it is very common at this age for students to be egocentric. The age of the student participants placed them at the final year of Piaget's preoperational stage of development, which states that most preoperational thinking is self-centred or egocentric (Peterson, 2010). Preoperational children can be very self-orientated and may have difficulty understanding any other perspective than their own (Peterson, 2010; Muller Mirza, Perret-Clermont, Tartas & Iannaccone, 2009). Until children have emerged from egocentrism, which is the inability to see other peoples' point of view, they will still focus on themselves and consider their opinion or participation to be at the forefront (Muller Mirza et al., 2009).

Student choice:

One aspect of interest that emerged in analysing student comments was the contribution of student choice. In this specific activity, the teacher had created a graphing activity, which required students (as a small group) to construct a graph of the favourite colours of students within their group. This graph was assembled on the ground using tape to show the x and y-axis, bits of coloured paper to indicate their favourite colours and white masking tape to label the graph. Following this and discussion students were able to choose what they wanted to graph as a group.

Emma: *I liked doing the graph because you get to choose.*

This student had a high level of interest with the graphing activity. This activity included movement, as students were required to ‘get up’ to construct the graph and to put their bit of coloured paper on the graph. This student found the task engaging because she was given some control over the task, providing her with a sense of ownership, which corresponds with the findings of Askew et al. (1997; cited in Attard, 2009).

Challenge:

There was one mention of challenge being enjoyable and this occurred in lesson 7 where the student was learning about fact families. Within this lesson, the teacher had set up a baseball field where students would run around the four bases writing one part of their fact family down on a whiteboard at each base.

Laura: *I liked this activity because it challenged myself.*

This student is recognising challenge in mathematics as enjoyable, which corresponds with the work of Fredricks et al. (2004). Fredricks et al. state that some students do have a preference for challenge. However, this is not always the case and some students prefer mathematics when it is presented in easier forms. Although distinct from each other, engagement and motivation are strongly associated. Motivational research suggested that a moderate level of challenge serves to enhance student learning and motivation, and thus positively affects student interest in learning (Turner & Meyer, 2004; Attard, 2009). Lepper and Hodell (1989, cited in Child, 2007) propose that challenge is one of the four main sources of intrinsic motivation, provided that the challenge is within reach of the child's development.

Frustration

The Kong et al. (2003) study identified boredom, dislike, difficulty, and 'tiredness' of mathematics within this category. The expression of boredom, dislike and difficulty were evident within lesson 8 but not in other lessons.

In lesson 8 the researcher noted some negative comments made by students. These comments referred to the worksheets as 'boring' due to being 'too easy'. These comments illustrate the reverse of the above section on challenge, under the category of interest, but they provide a similar idea that these students prefer to be challenged in mathematics.

Tim: *I'm not answering them, they are easy.*

Jack: *I'm not doing that one it's too easy… I've had enough.*

To overcome the boredom these two boys were experiencing with the worksheets they made it into a competition, as noted in classroom observations. They turned the completion of the worksheets into a race, seeing who could answer all the questions the fastest. Nett, Goetz, and Hall (2011) suggested that the experience of boredom is an unpleasant and undesired emotion usually caused by a lack of stimulation. In this instance, the students increased their focus by making the task more important through the avenue of competition (Rana, 2007; as cited in Nett et al., 2011).

It was observed by the researcher that many students in lesson 8 used behavioural avoidance strategies in response to the worksheets provided. Students expressed their frustration by asking for alternative activities, sharpening pencils, changing where they were sitting and chatting with friends. Similarly, this is reflected in Nett et al.'s (2011) study, which focussed on the coping mechanisms for boredom exhibited by students. This study labelled them *Criticizers;* students who coped through behavioural-approach strategies aimed at changing the situation by expressing frustration and *Evaders;* who endorsed behavioural-avoidance strategies (Nett et al., 2011).

Dislike:

The worksheet used in lesson 8 was a series of number sentences (approximately thirty questions), which students answered. There were two worksheets, the 'easier' option which had two-part number sentences and the 'harder' option which had three-part number sentences.

Three students' made direct reference to their dislike of worksheets:

Jack: *The activity I liked the most was I didn't, I didn't like the worksheets.*

Bec: The sheets weren't very good cause they didn't really help me cause they were really bad.

Lucy: Something that didn't help me learn were the number worksheets.

One student made reference to the difficulty levels of worksheets:

Laura: …the sheets because they weren't easy for me.

References to frustration from students (Table 4.1.) appear only in lesson 8. During lesson 8 there was no use of purposeful movement, and worksheets were used as the main teaching tool. This suggested a negative relationship with the use of worksheets as a medium of teaching. Ranson and Manning (2013) and Stigler and Hiebert (2009) report that teachers should move away from the use of solitary tasks in favour of more meaningful learning activities. Meaningful learning tasks increase interest in mathematics; students are able to relate to the mathematics learning and recognise its value (Fielding-Wells & Makar, 2008). Fielding-Wells and Makar, defined such tasks are those that are novel and personally interesting and relatable for students. However, it is important to note that it is possible to select and use worksheets that are relatable and meaningful for students, this is dependant on the teacher's section.

Kong et al.'s (2003) study shows a strong negative correlation between interest and frustration. The results from lesson 8 of the study suggested that the more frustration expressed the less interest was mentioned. This is conveyed in Table 4.1, where lesson 8 reported the lowest ranking for interest, and the only mention of frustration. One of the most significant findings in these results is the increased level of interest when there is no frustration present. This suggested that purposeful movement could help to reduce frustration in mathematics due to the high level of interest expressed by students when this teaching method is adopted. Kong et al. (2003) report that an increased level of interest and a decreased level of frustration has the potential to address the decline in student engagement within mathematics.

The relatedness of dimensions of engagement is also important to note, which reflects Fredricks et al. (2004) assertion that student engagement is a complex construct that involves the interaction between and within affective, behavioural and cognitive components. Within the findings a negative relationship is suggested between interest and frustration, which supports the strong negative correlation found by Kong et al.'s (2003) study.

Anxiety

Despite this being a category of Kong et al.'s (2003) framework, there was no data collected that suggested the students were experiencing anxiety within mathematics. This may be due to the low levels of frustration and high interest experienced across the observed lessons. It is suggested that prolonged frustration and poor performance in mathematics learning can subsequently contribute to mathematics anxiety (Park, Ramirez & Beilock, 2014).

Achievement Orientation

Kong et al. (2003) identified achievement orientation as the desire to achieve and the enjoyment of getting good results. There were very limited comments made by students that could be recognised as achievement orientation. This may be due to the age of the students or the researcher's prompts may not have been designed to elicit this response. Additionally, none of the tasks that were observed were summative in nature; therefore the attainment of 'good' grades may not have been at the forefront of students' minds.

One student made reference to how she felt when she did the most work in mathematics. Her comment suggested that she valued achievement orientation as she felt proud of herself when she completed the most work.

> *April: It made me very happy and proud because I done the most work because I smashed it.*

At the conclusion of lesson 2 (where the focus was on graphing), a post discussion was held with Miss O and she made reference to achievement orientation:

> *In particular the level of engagement in my activity was really high… because I think that having clearly set out the learning intention, they were able to know what they were meant to achieve by the end of the session.*

This comment suggested that Miss O recognised a link between achievement orientation and high student engagement levels. She implied that by clearly identifying the learning intention students were more interested and had a higher desire to achieve. A desire to achieve is one motivator of achievement orientation. Weiner's (1985; cited in Latu, 2004) attribution theory encompasses how individuals interpret events and how this relates to their thinking and behaviour. Within this study the student states she is proud of herself for doing the most work, which suggested she is both extrinsically and intrinsically motivated. Thus, extrinsically motivated because she had done the most work, and intrinsically motivated because she was proud of herself, which suggests an internal desire to learn.

Behavioural Engagement

Behavioural engagement encompasses an individual's positive conduct, measurements of their efforts, persistence, attention and their school commitment, which is often identifiable through extracurricular activities (Fredricks et al., 2004). Kong et al. (2003) identified three dimensions of behavioural engagement; attentiveness, diligence and time spent out of class. The data information is discussed under these dimensions.

Attentiveness

The students made no comments that could be coded as attentiveness.

Diligence

Few comments were made by students that could be recognised as diligence. The two comments that were made in regards to diligence indicated that the students were inclined not to 'give up' in their work habits:

Lilia: *I was practising and it got easier for me.*

Georgia: *In maths today I learnt tricky sums and I did them all.*

Interestingly, Lilia made the connection that through not giving up and practising the mathematics, the task got easier for her.

Non-Assigned Time Spent on Task

Time spent outside mathematics lessons was not a requirement for the age group in which this case study was conducted, as they were not given any ‘homework’. The prompting statements were not tailored to receive a response regarding time spent outside of class. However, it was noted by the researcher that on occasion students voluntarily used their lunchtime to further their mathematical understanding. This was specifically noted after lesson 2, where the focus was on graphing. A group of students took clipboards, paper and pencils outside and constructed their own column graphs. Many of these students were interested in students’ and teachers’ favourite colours and a few students looked at eye colour. This was all conducted through the initiative of the students, as no teacher influence was present.

In this study, behavioural engagement was not a significant factor and was not extensively mentioned in discussions with Miss O, or student video diaries. This may have been because the questions asked in the post discussion with Miss O and the prompting statements for students were not designed to receive this response. In regards to diligence, *Georgia* implied that she learnt difficult sums, but she did not give up and completed them all. This is supported in Fredricks et al.’s (2004) and Kong et al.’s (2003) study, as both associate high behavioural engagement with a student’s persistence in a difficult task. The researcher observed high behavioural engagement within a group of students when they volunteered their own lunch time to further develop their mathematical understanding regarding graphing. This was not prominent in Kong et al.'s findings, where extra work is seen more as duties rather than something of interest. However, this implies that students were assigned tasks to complete in their own time. Conversely, within this study students were not assigned work; they took it upon themselves to volunteer their time to further their understandings in non-assigned tasks. In fact, there was no teacher influence that was recognised to initiate this response. This group of students had a very high level of intrinsic motivation, as there were no such external drivers present, such as a reward. The students were motivated by internal factors: they were volunteering their time to spend on mathematics due to a high level of interest and enjoyment of what they had just learnt, in this case graphing. This reflects an intrinsic motivation and a true desire to learn from students (Benabou & Tirole, 2003; Deci & Ryan, 1985).

Cognitive Engagement

Cognitive engagement, according to Connell and Wellborn (1991; cited in Kong et al., 2003), is a measure of psychological investment in learning. There is a distinction in cognitive engagement between students using deep strategies, such as integration as distinct from surface strategies, where students rely on memorisation, (Kong et al., 2003). These individual categories will be further discussed, as well as student reliance on others.

Not only did the students' express enjoyment through purposeful movement but also many linked the movement to enhanced learning. For example:

David: *I liked Miss O's group the most because we did a lot of running around and I liked this because we got to learn new things.*

April: *Something that helped me learn was running around in Miss O's group doing focus it made me very happy and proud.*

Wilson: *I liked Miss O's group the most because you learn numbers and you're jumping around with all the numbers which is fun.*

Note: focus refers to the focus/learning intention for the lesson, which is usually the rotational group with the teacher.

Wood (2008) suggests that students' potential to learn mathematics is heightened through movement; specifically dance orientated movement. Students suggested the benefits of whole-body movement helped their learning in mathematics; one student specifically stated that running around helped her learning. In relation to the benefits of including movement and physical activity outside of the classroom, Praag et al. (2005) state that large-muscle movements cause neurotransmitter release, which initiates neuronal growth in the hippocampus. Although, increased brain cells from neuronal growth are not known to make individuals more intelligent, it does give a higher capacity for them to learn. This suggests the need for and benefits associated with physical activity and its purposeful inclusion in the classroom.

Use of Deep Strategies

The use of deep strategies is outlined in Kong et al.'s (2003) study as a preferable way to develop a transferable understanding of mathematics rather than relying on memorisation of content and procedures. Within lesson 5, students were able to articulate a deep strategy they had learnt for subtraction. Three out of six students recognised and expressed this deep strategy:

Tim: *I learnt that the counting backwards strategy helped me count backwards.*

Bec: *Miss O's group helped me count backwards.*

Laura: *Today in mathematics I learnt the counting back strategy.*

A student then went on to explain what manipulative helped her with this strategy:

Laura: *Something that helped me learn was the number charts.*

Surface strategies

Surface strategies rely on memorisation of procedures and content. References to surface strategies made by students were very low. One student mentioned the use of surface strategies within lesson 8, which is the lesson that had an absence of purposeful movement. However, even *Wilson's* comment is quite hard to interpret because of the lack of information; he may not be referring to surface strategies, however, his response implies he is:

Wilson: *I learnt number sentences.*

Few students made mention to the strategies they used when undertaking mathematics; this may have been a result of the prompts that students received in the study. However, within lesson 5, a considerable number of students referred to a deep strategy they used to count backwards. To teach the ‘counting back’ strategy the teacher used purposeful movement when students had to jump on a number line, counting backwards with each jump. This was noted as being more challenging when the subtraction was larger. For example, 94-54 would take a long time when jumping and counting back in ones. In this instance students were encouraged to count back in tens, so jump back five times to mirror five tens, and then ones, four ones to arrive at their answer. This was considered a successful learning activity as three out of six students in their video diaries mentioned the counting back strategy with one student stating that it helped him count back. This finding is consistent with Spielmann’s (2012) study where he identified the benefits of learning kinaesthetically. He suggested that movement contributes to a child’s cognitive development.

Reliance

The term reliance is often regarded to as negative, where students are too reliant on others to complete work individually. However this was not noted in this study as being a negative, in fact it suggested positive group work. Comments made by students implied that they enjoyed working as a part of a group and could see the benefit of working of together:

Mark: *Something that helped me learn was working with ... [student]*

Bec: *I liked this group cause um it was fun and we got to do it all together.*

Emma: *The people that were around me were helping me learn.*

Lilia: *Someone that helped me learn was [student] did tricky sums and I answered them all.*

This supports Latu's (2004) findings, where students recognised the benefits of working together in a group to help their mathematical understanding and learning. In *Bec's* comment, she positively expressed a relationship between interest (affective engagement) and reliance on others, specifically working with her peers. This relationship was not reflected in Kong et al.'s (2003) study, which suggested that interest had no statistical influence on whether reliance is present. This offers a point of difference between this study and Kong et al.'s, which could be influenced by many different factors, such as age of students, content being learnt, teaching style and different personalities.

Four students made very similar references to teacher assistance being a benefit to learning across a number of lessons:

Jack: *Something that helped me learn was teacher.*

Acknowledgement of Mathematical Content

Acknowledgment of mathematical content is not noted in Kong et al.'s (2003) study as being a sub category for cognitive engagement. However, within this study it was necessary to add this category as 39 student references were made explaining what they had learnt, however they did not go further to explain a deep or surface strategy:

Emma: *In mathematics today I learnt that graphing tells you information.*

Nick: *I learnt about Australian coins and how much they [are] worth.*

Amy: *I learnt that you can add numbers up.*

Tim: *I learnt that [fact] families are two take-aways and two pluses.*

It has been suggested that a focus on making learning 'fun' can result in loss of focus on developing mathematical understandings (Askew, Brown, Rhodes, Johnson & William, 1997, cited in Attard, 2009). In a report by Askew et al. (1997, cited in Attard, 2009), effective teachers are those who focus students on mathematical learning and understanding rather than merely providing a satisfying classroom experience. However, Attard (2009) and Sousa (2008) confront this claim and suggest that instances of sedentary learning for long periods of time can cause frustration and low attention in students.

The comments expressed by students in this study suggest that mathematical cognition is not lost when purposeful movement is a significant feature of the teacher's pedagogy. In fact, it suggests higher interest in mathematical learning and a positive affect towards the content. Due to the high number of students' acknowledgments of mathematical content in lessons 1 to 7, it is thought that mathematical learning is not lost. Through the use of purposeful movement many students implied in their comments that they are learning mathematical concepts beyond surface level and show a very high affect towards this learning style. This indicates that mathematical learning is a main focus of the teacher, and is noted as one of the reasons she includes purposeful movement to engage students. This is expressed through several, similar comments from the teacher:

You get better learning retention if they are engaged.

According to McGregor, Swabey and Pullen (2015), teachers who incorporate movement into their everyday classroom learning, reported high retention of information by their students. This is similar to the research findings of Speilmann (2012), which reported that through movement based learning, student retention is higher as well as increased academic performance.

Chapter Summary

The results from the transcripts of student video diaries and teacher interviews/post discussions closely mirrored those of Kong et al. (2003). This gave this research study a framework to base the results on. It identified the effect purposeful movement has on affective, behavioural and cognitive engagement, under the dimensions of Kong et al.'s framework. In addition, the researcher added a new dimension, under cognitive engagement to Kong et al.'s existing framework; acknowledgment of mathematical content. This new category was necessary as many students made reference to what they had learnt, however they did not go further to explain a deep or surface strategy. These dimensions of engagement were discussed in detail in this chapter, and conclusions and recommendations follow in Chapter 5.

Chapter 5

Conclusion and Recommendations

Chapter Introduction

This chapter revisits the aims of the research project. It then provides a summary of the research, highlighting the key findings. It concludes by making several recommendations, including some suggestions for possible areas for future research opportunities.

Answering the Research Question

Research Question:

What effect does purposeful movement have on student engagement when undertaking mathematics?

In order to answer the research question qualitative data was collected from teacher interviews, student video diaries and classroom observations to develop an in depth analysis of a case. Chapter 4 presented the Results and Discussion, which were linked to relevant literature to identify the similarities and differences between the results of this study and previous studies. This led to the key findings of the study as outlined below.

Key Findings

This research project was exploratory in nature and was designed to investigate the main aim of the study, which was whether there is a link between purposeful movement within mathematics and an increase in overall student engagement. This was investigated from the perspectives of the teacher and the students, in order to receive an insight into their perceptions on this topic.

The study undertaken suggested that purposeful movement appears to be a significant factor in high student engagement, particularly affective engagement. In fact, one of the most significant findings of this study was the high level of interest and very low level of frustration identified by the participating students. Students referred to interest in their video diaries 59 times, which is substantial in a small sample size. Students' only referred to frustration four times within the study and all of these responses were present in lesson 8, where no purposeful movement was embedded in the learning of mathematics.

Students made many extensive comments regarding interest in terms of affective engagement. Therefore, it was necessary to divide student comments regarding interest into sub-categories: real-life, self/ego-centric, student choice/empowerment and specific mentions to interest and purposeful movement. In the mathematical lessons that included purposeful movement students made many comments about the previously stated sub-categories as interesting or enjoyable parts of mathematics.

When analysing the data, the researcher used Kong et al.'s (2003) framework for engagement, and open coding for any salient data, which could not be coded under Kong et al.'s framework. However, the addition of a category to this framework, acknowledgment of mathematical content, was necessary as there were extensive comments made by students that could not be coded under the identified categories for cognitive engagement. This addition was significant to this research as it suggested that mathematical content learning was not lost through the inclusion of purposeful movement in Miss O’s pedagogy. This is of high importance for educational professionals as it suggests that purposeful movement within mathematics has the potential to increase interest and decrease frustration, which could be a factor in slowing the decline of engagement in mathematics.

Recommendations

The study suggested the benefits of purposeful movement and its effect on increased student engagement with mathematics. Therefore, educators would benefit from having the opportunity to attend professional development and conferences regarding the necessary strategies needed to incorporate movement into their everyday classroom learning. Educators need to become aware of the benefits of movement and how to include this purposefully in their pedagogy.

Future Research

This research has provided an answer to the research question and aims of the study. It has also provided a sound contribution to the current field of research. However, due to the small sample size investigated it is not representative of the population. Therefore, further research would extend and develop the significant findings of this study. Future studies could involve a much larger sample size including a number of schools, and varying year levels of students. To determine the perceptions of students in middle and upper-primary a study across multiple year levels would be interesting. Additionally, further research involving control groups where the teacher did not use strategies for kinaesthetic learning as their main form of pedagogy could provide further information relating to engagement in mathematics.

Another area of research could be focusing on different aspects of mathematics, such as number, geometry and measurement and if there were particular aspects in which purposeful movement was more or less linked with student engagement. Particular strands of mathematics may lend themselves more easily into purposeful movement than others. Therefore, it would be necessary to examine all different strands of mathematics to see if the inclusion of purposeful movement had an effect on increased student engagement.

Other findings to expand upon include examining the link between behavioural and cognitive engagement and purposeful movement more deeply. Engagement is a multi-faceted construct and highly complex (Fredricks et al., 2004). This study was exploratory and identified that affective engagement, specifically interest, had a strong association with purposeful movement. This may have been a product of the research tools chosen. In relation to cognitive engagement, the researcher could investigate this more deeply by undertaking a longitudinal study with a larger sample size. This could include the collection of work samples from children, which would allow further examination of their conceptual understanding, use of strategies and reliance on others.

This study indicated that the participating students, aged between six and seven years of age showed a very high interest in mathematics, influenced by purposeful movement. This should be of great significance to educators as it shows the importance of this type of pedagogy. The high interest levels noted and the low levels of frustration present, suggested the potential of purposeful movement to increase student engagement in mathematics. This is a positive outcome, in light of the rapidly declining rate of student engagement with mathematics.

Chapter Summary

This research has addressed the research question, and provided significant results in regards to the positive effect purposeful movement has on student engagement when undertaking mathematics. From the data collected, analysed and discussed, it was clear that within the sample, students reported high levels of interest when purposeful movement was involved in their mathematics learning. From the responses, students made no comments that implied anxiety and their frustration levels were very low and were only present when movement was not included. Ways to reduce the decline of engagement within mathematics is the focus of this research, and this study suggested that purposeful movement has the potential to increase positive affective engagement, without the mathematics learning being compromised.

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Appendices

Appendix A

Teacher interview questions

Questions to be asked in the first interview:

1. How would you define purposeful movement?
2. How do you incorporate movement into your mathematics pedagogy?
3. Why do you choose to include movement within mathematics?

Questions to be asked after every Mathematics lesson:

1. What opportunities did students have for purposeful movement in this lesson?
2. How do you think students responded to this?
3. How would you rate the level of engagement of students in the lesson?
4. Did the lesson achieve its objectives?

Appendix B

Observation Pro-forma

Summary about task:

Summary about engagement:

Teacher-student interaction:

Student- teacher interaction:

Time	Learning episode	Incidental movement	Purposeful movement	Comments

(N.B. This was enlarged when used in classroom observations)

Appendix C

Student prompts

1. In mathematics today, I learned that ….
2. Something that helped me learn was ….
3. The activity I liked the most was ….
4. I liked this because …

Appendix D

Approval from *HREC*

Social Science Ethics Officer
Private Bag 01 Hobart
Tasmania 7001 Australia
Tel: (03) 6226 2763
Fax: (03) 6226 7148
Katherine.Shaw@utas.edu.au

UTAS

HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

24 April 2015

Dr Tracey Muir
Education
Private Bag 1307

Dear Dr Muir

Re: FULL ETHICS APPLICATION APPROVAL
Ethics Ref: H0014824 - Get moving in maths: Engaging students in active mathematical experiences

We are pleased to advise that the Tasmania Social Sciences Human Research Ethics Committee approved the above project on 20 April 2015.

This approval constitutes ethical clearance by the Tasmania Social Sciences Human Research Ethics Committee. The decision and authority to commence the associated research may be dependent on factors beyond the remit of the ethics review process. For example, your research may need ethics clearance from other organisations or review by your research governance coordinator or Head of Department. It is your responsibility to find out if the approval of other bodies or authorities is required. It is recommended that the proposed research should not commence until you have satisfied these requirements.

Please note that this approval is for four years and is conditional upon receipt of an annual Progress Report. Ethics approval for this project will lapse if a Progress Report is not submitted.

The following conditions apply to this approval. Failure to abide by these conditions may result in suspension or discontinuation of approval.

1. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval, to ensure the project is conducted as approved by the Ethics Committee, and to notify the Committee if any investigators are added to, or cease involvement with, the project.

2. Complaints: If any complaints are received or ethical issues arise during the course of the project, investigators should advise the Executive Officer of the Ethics Committee on 03 6226 7479 or human.ethics@utas.edu.au.

Appendix E

Formal permission from Catholic Education Office

TASMANIAN CATHOLIC education office

27 May 2015

Ms Jessica Gleadow
Honours student
University of Tasmania
Locked Bag 1307,
Launceston, 7250

Dear Jessica

Application for approval to conduct research at
Launceston: Get moving in maths: Engaging students in active mathematical experiences

I am pleased to approve your application to conduct research at
School, Launceston as described in your letter of 7 May 2015 and under the conditions established by the Health and Medical Human Research Ethics Committee, University of Tasmania, and supervision of Dr Tracey Muir, Dr Jill Wells and Associate Professor Karen Swabey.

Please liaise with to ensure that all requirements which ensure privacy, confidentiality, feedback to the school, compliance with school policies whilst at the school, are adhered to.

I wish you all the best in your project.

Yours sincerely

Peter Douglas

Peter Douglas
Head of School Services, North

Appendix F

Principal approval

7th May 2015

To whom it may concern

Re: Jessica Gleadow Honour's Project:

I am writing on behalf of our School Board and after consultation with Peter Douglas, Head of Schools North: Tasmanian Catholic Education Office, in relation to Miss Jessica Gleadow working with students at our school as part of her Honours Project.

Our school is supportive of this and subject to the usual confidentiality and privacy protocols, more than happy to accommodate what is needed for Jessica to complete the project. We understand that data will be required from students as part of this.

We think very highly of Jessica as a future teacher and she has a ongoing connection with our School and wish her every success in this, her final year.

If there is anything else that is required of us we are happy to discuss this further.

Yours sincerely,
Principal.

Appendix G

Teacher Information sheet/ consent form

UNIVERSITY of TASMANIA | FACULTY OF EDUCATION

Teacher Information Letter

Get moving in maths: Engaging students in active mathematical experiences

Dear_____________,

Invitation

You are invited to participate in a study to explore the nature of purposeful movement in mathematics lessons. Jessica Gleadow is conducting this study as part of an honours project in 2015, under the supervision of Dr Tracey Muir, Dr Jill Wells and Associate Professor Karen Swabey.

What is the purpose of this study?

The study aims to investigate what purposeful movement looks like in the context of mathematical lessons, and whether or not this affects student engagement. We are particularly interested in providing an insight into the teacher's and students' experiences with purposeful movement in mathematics lessons, in order to develop evidence-based recommendations for effective mathematical pedagogy involving movement.

Why have I been invited to participate?

You have been selected to participate in the study because you are currently a classroom teacher who is known for incorporating purposeful movement into your pedagogy.

What will I be asked to do?

If you consent to participate in this study, you will be invited to contribute to the data in the following ways-

1) by having your teaching observed
2) by participating in audio-reordered interviews after each lesson (these will go for no longer than 15 minutes)
3) through distributing information and consent forms to the students and their parents/guardians.

Further details of the data gathering procedures are provided below.

Lesson observations

The researcher will observe approximately 6-12 mathematics lessons over the course of a three-week period. Lesson observations will be unobtrusive and the students will know and understand why the researcher is there (to research how they learn). Leading up to the observations the researcher will spend some time in the classroom with the students and teacher, getting to know them to ensure that they are comfortable with the researcher's presence.

Data collected during the lesson observations will be in the form of field notes. Whilst observing, the researcher will document the teaching and learning interactions that take place between yourself and participating students. During the last 15 minutes of each lesson, with your permission, some students who have parental consent will be invited to answer some questions in the form of a video diary, where they record their responses privately on an iPad that will be provided by the researcher. Students will be responding to three prompts outlined by the researcher.

Audio- recorded interviews
After each lesson observed by the researcher, you will be invited to participate in an interview with the researcher at a mutually convenient time, as soon after the lesson as practically possible. Each interview will be conducted in a face-to-face format, it will go for no longer than 15 minutes and it will be audio-recorded and transcribed later. The interview questions will be open-ended to uncover your perspectives on this topic. The questions will be focused on the objectives of the lesson and the uses of purposeful movement within the mathematics lesson. You will be offered the option to read and amend the transcripts of your own interviews.

Are there any possible benefits from participation in this study?

The study will give you an opportunity to reflect upon and examine your own practice. Furthermore you will have the opportunity to reflect upon how your students learn. Other teachers, principals and mathematics researchers may be interested in the findings of this study so they too can reflect upon teaching practices to assist them in identifying practices, which are most influential in terms of student learning of mathematics.

Are there any possible risks from participation in this study?

Although this is not anticipated, there is a slight chance that you may feel anxious during an interview or during a lesson where your teaching is being observed. During the interviews you can decline to answer any or all questions and withdraw from the study without any consequence. You will be able to view and amend any interview transcripts. You may ask for any unprocessed data to be withdrawn from the study within two weeks of contributing the data.

You are the only teacher that is participating in this study therefore there is a risk of being identified easily in publications by members of the school community. The risk associated with being identified is low because the school community would be familiar with your classroom practice.

What if I change my mind during or after the study?

You may choose to decline your participation at any time without providing an explanation. Furthermore you will be able to view and amend your own interview transcripts and ask that any unprocessed data you have contributed be withdrawn at any stage of the project.

What will happen to the information when this study is over?

At the conclusion of the data gathering, hard copies of interview and video-recording transcripts will be stored on the Launceston campus, in a locked cabinet. Names and other identifying information will be removed from the data and replaced with codes; these codes will be stored separately to the transcripts. All electronic data and computer files will be password protected and stored on a secure server in the Faculty of Education, Launceston campus. No sooner than 5 years from the publication of the thesis, all transcripts and field notes will be securely shredded and all computer files will be deleted.

How will the results of the study be published?

After the completion of the honours project at the end of 2015, the researcher will provide a summary report of the data for the participating teacher and students. The participating school and teacher will be provided with the thesis in electronic form, which will also be available to students and parents from the school upon request.

What if I have questions about this study?

If you have any questions about this study, please feel free to contact one of the researchers at any time:

Dr Tracey Muir: University of Tasmania (Launceston) Telephone: 6324 3261, email: Tracey.Muir@utas.edu.au

Associate Professor Karen Swabey: University of Tasmania (Launceston) Telephone: (03) 6324 3512 email: Karen.Swabey@utas.edu.au

Jessica Gleadow: University of Tasmania (Launceston) Email: jgleadow@utas.edu.au

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on +61 3 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number [H0014824].

Thank you for taking the time to consider this study. If you wish to take part in it, please sign the consent form attached. This information sheet is for you to keep.

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Teacher Consent Form

Get moving in maths: Engaging students in active mathematical experiences

1. I have read and understood the Information Sheet for this study.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study involves:
    - Having my teaching observed by the researcher for up to 12 of my Mathematics lessons.
    - Participating in a post-lesson audio recorded interview following each lesson
    - My students individually videoing their responses to prompts.
4. I understand that my participation in this study involves low risk.
5. I understand that all research data will be securely stored on the Launceston campus of the University of Tasmania.
6. Any questions that I have asked have been answered to my satisfaction.
7. I understand that the researcher(s) will maintain confidentiality and that any information that I supply to the researcher(s) will be used only for the purposes of the research. I understand that in any public documents arising from this research, codes will be used for my own name and the names of my school and students.
8. I understand that the results of the study will be published so that I cannot be identified as a participant.
9. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    If I so wish, I may request that any unprocessed data I have supplied be withdrawn from the research within two weeks of contributing the data.

I give consent to participate in this study. Yes No (Please circle)

Participant's name:

____

Participant's signature:

____

Date:

____

Statement by Investigator

I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name:

____

Investigator's signature:

____

Date: __________________________

Appendix H

Parent Information sheet and consent form

UNIVERSITY of TASMANIA | FACULTY OF EDUCATION

Parent Information sheet

Get moving in maths: Engaging students in active mathematical experiences

Dear Parent/ Guardian

Your child has been selected to participate in a study to explore how incorporating movement affects students' engagement within mathematics. This study is being conducted for an Honours project for Jessica Gleadow under the supervision of Dr Tracey Muir, Dr Jill Wells and Associate Professor Karen Swabey.

What is the purpose of this study?
The purpose of this study is to explore ways that your child's teacher incorporates movement into her teaching of mathematics. The study aims to investigate what purposeful movement looks like in the context of mathematical lessons, and whether or not it affects student engagement. We are particularly interested in providing an insight into the teacher's and students' experiences with purposeful movement in mathematics lessons, in order to develop evidence-based recommendations for effective mathematical teaching involving movement.

Why has your child been invited to participate?
Your child has been selected to participate in this investigation because he/she is in the class of the teacher that has been selected to participate. Your child's participation or non-participation will in no way interfere with his/her learning and it will not impact upon his/her involvement in the classroom and academic achievement.

What will your child be asked to do?
If you and your child consent to your child's participation in this study, he/she will be invited to contribute data in the following ways:

- by being part of the class that will be observed by the researcher
- by participating in a video-recorded diary following some lessons

Further details of each of the above activities are given in the following sections.

Lesson observations

The researcher will observe up to 12 of your child's mathematics lessons and take notes. If you do not wish for your child to be involved in this part of the research then he/she will still attend the lessons as usual but the researcher will not observe or take notes on any aspect of your child's involvement. The child will not be asked to do anything differently; the class will be conducted in the usual ways.

Recorded student video diaries
After each lesson, up to 4 children will be invited to record their thoughts about the lesson using a video diary on an iPad. Different children will be selected each day to ensure that all those who have consent will be given a turn. Only children with parental consent will do this. The recording will only be seen by the researcher and will not be shown to the classroom teacher or other students. The students will be given the following prompts to respond to:

In mathematics today, I learned that ….
Something that helped me learn was ….
The activity I liked the most was ….
I liked this because …

The use of the iPad was selected as it removes the necessity for children to write and would be a fun and novel experience for young children. This is a reliable data collection method.

Your informed consent

If you agree for your child to participate in this study please provide consent by signing the attached consent form. You may give consent for your child to contribute to some, all or none of the components of this research.

Are there any possible benefits from participation in this study?

Participation in this study will give your child the opportunity to reflect on his/her learning in mathematics and to identify ways that he/she enjoys to learn.

The mathematics education research community and the teaching community may benefit from the findings of this study in terms of identifying the kinds of teaching practices that are most influential in assisting students in their learning of mathematics.

Are there any possible risks from participation in this study?

Although it is not anticipated, there is a chance that your child may feel anxious during the lesson that is being observed and or whilst answering the questions that are recorded on the iPad. At any time during the study your child can say 'no' to recording their response.

What if I change my mind during or after the study?

If you decide to withdraw your child's participation at any time, you may do so without providing an explanation.

What will happen to the information when the study is over?

At the conclusion of the data gathering hard copies of interview and students' video-recording transcripts and audio recordings will be stored on the Launceston campus (University of Tasmania). These will be kept in a locked cabinet in the office of one of the researchers that is only available to the researchers. Names and other identifying information will be removed from the data and replaced with codes. All electronic data and computer files will be password protected and stored on a secure server in the Faculty of Education, Launceston campus. No sooner than 5 years from the publication of the thesis, all transcripts and field notes will be securely shredded and all computer files will be deleted.

How will the results of the study be published?

After the completion of the honours project at the end of 2015, the researcher will provide a summary report of the data to the school. Your child, his/her teacher and your child's school will be anonymous in all publications of results. The participating school and teacher will be provided with the thesis in electronic form, which you will be able to access from the school, upon request.

What if I have questions about this study?

If you have any questions relating to this study, please feel free to contact one of the researchers at any time:

Dr Tracey Muir: University of Tasmania (Launceston) Telephone: 6324 3261, email: Tracey.Muir@utas.edu.au

Dr Jill Wells: University of Tasmania (Launceston) Telephone: 6324 3136, email: Jill.Wells@utas.edu.au

Associate Professor Karen Swabey: University of Tasmania (Launceston) Telephone: (03) 6324 3512 email: Karen.Swabey@utas.edu.au

Jessica Gleadow: University of Tasmania (Launceston) Email: jgleadow@utas.edu.au

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on +61 3 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number [H0014824].

Thank you for taking the time to consider this research. If you would like your child to participate in this study, please indicate on the consent form, the aspects of the research in which you agree for your child to be involved and sign it. Please place your consent form in the envelope provided and hand it back to your child's classroom, where the researcher will collect it. This information sheet is for you to keep.

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Parent Consent form

Get moving in maths: Engaging students in active mathematical experiences

1. I have read and understood the Information Sheet for this study.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study involves:
   - Having my child's involvement in up to 12 of his/her mathematics lessons observed by the researcher.

   I give consent for my child's involvement in these lessons to be observed.

   (Please circle) Yes No

   - My child participating in an individual video recording after some mathematics lessons, where he/she responds to the outlined prompts.

   I give consent for my child to participate in the video-recordings.

   (Please circle) Yes No

4. I understand that my child's participation in this study involves low risk.
5. I understand that all research data will be securely stored on the Launceston campus of the University of Tasmania.
6. Any questions that I have asked have been answered to my satisfaction.
7. I understand that the researcher(s) will maintain confidentiality and that any information that my child supplies to the researcher(s) will be used only for the purposes of the research.
8. I understand that the results of the study will be published so that my child cannot be identified as a participant.
9. I understand that my child's participation is voluntary and that he/she may withdraw at any time without any consequences.

If I so wish, I may request that any unprocessed data supplied by my child be withdrawn from the research.

Participant's name:

____

Participant's signature:

____

Date:

____

Statement by Investigator

I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name:

____

Investigator's signature:

____

Date:

____

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Appendix I

Student information sheet and consent form

UNIVERSITY of TASMANIA | FACULTY OF EDUCATION

Student Information Sheet

Get moving in maths: Engaging students in active mathematical experiences

Dear student,
My name is Miss Gleadow and I am writing to tell you about a research project that I am doing and to ask you if you would like to take part. I am a student at the University of Tasmania, and the work I do with you will be used to help my learning as part of my University degree.

You would already know that your teacher teaches maths in a fun way. ……… includes lots of ways for you to move around and be physically involved in what you are learning. The reason for this project is to find out how your teacher includes physical movement into your maths lessons and I would like to find out more about this because I think this helps you to learn.

If you decide to take part we will be working together until July 2015. Your class will carry on as normal and your maths lessons will still be on same topics that you would normally learn. I would like to visit up to 12 of your maths lessons and during these lessons I would like to watch and take some notes. This means I can record what your teacher and your classmates are doing in maths. These notes will be locked away at the University so no one but the researchers can see your work. At the end of your maths lessons I might ask some of you to go into a quiet space and record what you learnt and what you enjoyed about the lesson on an iPad. I will make sure that no one that isn't involved in the project will see your video. I will even delete the videos once I have watched them.

You won't have to do anything that makes you feel unsafe or uncomfortable. What you do is the same as what you would normally be doing in your maths lessons.

I would like to ask you now if you want to take part. Your parents have also been asked if they give permission for you to participate. If you agree and want to be apart of the project, you will need to sign the consent form attached. Even if you do give us permission now, you can always change your mind. If you do change your mind, no one will be upset or treat you differently.

Thank you,
Miss Gleadow

Student Consent form
Get moving in maths: Engaging students in active mathematical experiences

I have read the Information sheet for this project and I understand what I am being asked to do.

I agree that I can:

- be observed by Miss Gleadow for up to 12 maths lessons.

(Please circle one) Yes No

I would like to:

- participate in an individual video recording after some Mathematics lessons, where I will respond to the outlined prompts using an iPad to record myself.

(Please circle one) Yes No

I understand:

- that my participation in this study involves low risk.
- that all research data will be securely stored at the University of Tasmania.
- that my participation is voluntary and that I may withdraw at any time.

Child's Name: ____

Child's Signature:____

Date: ________________________

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