THE EFFECT OF ‘6 BRICKS’ GUIDED PLAY ON GRADE TWO LEARNERS’ VISUAL PERCEPTION AND REASONING ABILITIES

by

Amina Brey

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I, Amina Brey 208072174, hereby declare that the Dissertation for Doctor of Education is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another university or for another qualification.

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This study investigates the possible effects that construction play (in the forms of guided play and guided play with exploratory talk) using the ‘6 Bricks’ approach has on the development of learners’ visual perception and reasoning abilities. The intervention, which aimed at developing visual perception, required the participating teachers to use the ‘6 Bricks’ approach three times a week over a period of six months. The sub-set of teachers in the intervention group who were also expected to facilitate discussion to promote reasoning abilities were tasked with additional ‘6 Bricks with exploratory talk’ activities once a week spread over ten weeks during the intervention period. The study followed an explanatory sequential mixed-method design with pre-post-testing using comparison and experimental groups to generate both quantitative and qualitative data. The sample included Grade 2 teachers and their learners in five purposively selected schools in Port Elizabeth, South Africa. Quantitative data were generated via pre-post-analysis of two tests, namely, the Visual Perceptual Aspects Test (VPAT) and Raven’s Coloured Progressive Matrices (RCPM) test. Statistically significant improvements were found in the experimental group’s pooled VPAT subtest scores as opposed to only three for the comparison group’s VPAT subtest scores. Statistically significant improvements in mean scores were achieved by some schools in the exploratory talk experimental group for the RCPM test. Qualitative data, obtained from teacher record sheets, researcher’s observations and semi-structured, open-ended teacher interviews were triangulated against the quantitative data. The findings, when considered in light of the literature, suggest that the ‘6 Bricks’ approach can contribute to the development of learners’ visual perception. In the instances when using the ‘6 Bricks’ approach with exploratory talk was implemented successfully, improvements in learners’ reasoning abilities were observed.
Key words: ‘6 Bricks’; visual perception; exploratory talk; reasoning abilities; Visual Perceptual Aspects Test; Raven’s Coloured Progressive Matrices test.
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<td>RCPM</td>
<td>Raven’s Coloured Progressive Matrices</td>
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<tr>
<td>VD</td>
<td>Visual discrimination</td>
</tr>
<tr>
<td>VFC</td>
<td>Visual form constancy</td>
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<td>VM</td>
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<td>Visual figure-ground</td>
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<td>VA/S</td>
<td>Visual analysis and synthesis</td>
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1. INTRODUCTION

Play lays the foundation for early learning and later academic success (Lockhart, 2010). Its relationship to early learning in the domains of literacy and numeracy, and later academic success in science, technology, engineering and mathematics (STEM) has gained, and continues to gain, wide recognition (Bergen, 2009; Ferrara, Hirsh-Pasek, Newcombe, Golinkoff, & Lam, 2011; Park, Chae, & Boyd, 2008; Pirrone, Nicolosi, Passanisi, & Nuovo, 2015; Verdine et al., 2013; Verdine, Golinkoff, Hirsh-Pasek, & Newcombe, 2014). Play also contributes to the development of the physical, social, emotional, cognitive, intellectual, linguistic, and creative domains (Ferrara et al., 2011; Ginsburg, 2007; Hewes, 2007; Smith & Pellegrini, 2013; Wardle, 2007). The development and refinement of perceptual skills, such as visual perception, continue through early and middle childhood (Kellerman & Arterberry, 2006; Rosner, 1993; Vlok, Smit, & Bester, 2011; Warren, 1993; Williams, 1983). Research indicates that 75-90% of classroom learning depends on vision (Kranowitz, 2005) and that the development of visual perception enables learners to acquire reading, writing, spelling and mathematical proficiency (Clutten, 2009), as well as to carry out most of the activities of daily living (Richmond, 2010).

Donald, Lazarus, and Lolwana (2010, p. 53) explain that “development does not just happen to children. It is also based on their active engagement with and exploration of their physical and social world.” They suggest that, in order to optimise development, teaching and learning needs to employ active, purposeful, structured, exploratory processes. One enabling of such exploratory processes is ‘productive discussion’ in classrooms (Resnick, Asterhan, &
Clarke, 2015). The term ‘productive discussion’ covers a number of descriptors such as ‘collaborative reasoning’ (Chinn & Anderson, 1998; Reznitskaya et al., 2009); ‘critical discussion’ (Keefer, Zeitz, & Resnick, 2000); ‘accountable talk’ (Michaels & O’Connor, 2002); and ‘exploratory talk’; but all have in common the open sharing of ideas, receptiveness to the ideas of others, constructive conflict and well-argued counterproposals in order to reach consensus in groups (Mercer & Littleton, 2007). Exploratory talk, the form of productive discussion that is focused on in this study, has been found to promote reasoning abilities by encouraging children to engage critically and constructively with each other’s ideas (Alexander, 2008; Mercer & Sams, 2006).

While much has been said in the literature about the development of visual perception and reasoning, there is a paucity of empirical data on the development of visual perception in middle childhood and on promoting exploratory talk in children younger than eleven years through guided construction play. It therefore appeared that investigating these issues could be fruitful in terms of contributing to understandings of the development of visual perception and reasoning in young children while using a guided play approach. The newly developed and un-researched ‘6 Bricks’ approach, conceptualised in 2013 by Brent Hutcheson (personal communication, August 06, 2014), presented an opportunity to investigate the development of visual perception and exploratory talk in children younger than eleven years through guided construction play. It is in light of the lacunae noted above, and the ‘6 Bricks’ opportunity that presented itself, that this research study investigates the effect of guided play and guided play with exploratory talk when using the ‘6 Bricks’ approach on the development of visual perception and reasoning abilities in Grade 2 learners.
2. **PLAY**

Play continues to fascinate and intrigue educational psychologists, educators, therapists, researchers, and scholars of child development and learning as it is directly related to children’s development (Gauntlett, Ackermann, Whitebread, Wolbers, & Wechstrom, 2010; Ginsburg, 2007; Hewes, 2007; Ness & Farenga, 2007; Stannard, Wolfgang, Jones, & Phelps, 2001). Play promotes the learning of pre-academic skills and concepts (Bodrova & Leong, 2003), and has been credited with advances in verbalisation, vocabulary, language comprehension, mathematical skills, attention span, imagination, concentration, impulse control, curiosity, visual perception, problem-solving strategies, reasoning, cooperation, empathy, and group participation (Linder, Powers-Costello, & Stegelin, 2011; Nath & Szücs, 2014; Smilansky & Shefatya, 1990). Diezmann and Watters (2000) go as far as to state that the foundation for science and mathematics is built through play during the early childhood years.

Construction play involves the use of concrete manipulatives/objects with a predetermined shape and size, for example, Duplo Blocks, to represent something else (Stannard et al., 2001). Pirrone et al. (2015, p. 153) note that “When children manipulate and assemble pieces, building-block play furnishes opportunities to learn and practice visual perception along with gross and fine motor skills. As children handle blocks, they become mentally active, learning to interpret and process sensory information.” The ‘6 Bricks’ approach is a recent Duplo Bricks Lego development aimed at younger children. Duplo bricks are larger than the standard Lego blocks and can be more easily manipulated by small hands. Six blocks were chosen as research indicated that children have to build outside their field of vision within five steps using five manipulatives in order to remain engaged (Hutcheson, personal communication, August 06, 2014). While five Duplo bricks are the perfect number to do this they do not provide a middle point for bilateral integration exercises. As costs are a factor for South African schools, Hutcheson believes that restricting the sets to ‘6 Bricks’
provides a scalable, cost effective and simpler solution for many schools in South Africa (Hutcheson, personal communication, August 06, 2014). Also, as noted earlier, during construction play with blocks, children become mentally active and learn to interpret and process sensory information via developing the visual perception abilities required for constructing logico-mathematical knowledge and skills (Hanline, Milton, & Phelps, 2010; Mitchell & Burton, 1984; Stannard et al., 2001). It was for the above reasons that the ‘6 Bricks’ approach was used in this study on the possible development of visual perception and reasoning skills.

3. VISUAL PERCEPTION

Learners use their perceptual abilities to enable optimal learning (Vlok et al., 2011). Dednam (2005a) claims that the most crucial perceptions which enable learners to perform adequately in their schoolwork are visual, auditory and tactual-kinaesthetic perceptions, with approximately 20-30% of learners tending to learn more effectively through the auditory channel, while 40% of learners tend to learn more effectively through the visual channel (Schneck, 2005). During middle childhood the focus of development is on the refinement of all fine motor, cognitive and perceptual skills, of which visual perception is one aspect (Wait, 2004). However, the importance of visual perception in a learner’s understanding of the environment can be best understood when it is considered that 70% percent of all sensory receptors are found in the eye (Ayhan, Aki, Mutlu, & Aral, 2015), and the fact that visual perception plays a fundamental role in a learner’s ability to master academic skills such as reading, writing, spelling and mathematics (Clutten, 2009).

Visual perception is a dynamic, constructive process that integrates all other senses (Cheatum & Hammond, 2000; Groffman, 2006; Wade & Swanston, 2001; Williams, 1983). It involves the active process of identifying, organising, analysing and interpreting visual
information and giving it meaning (Advanced Vision Therapy Center, 2016; Clutten, 2009). According to Kellerman and Arterberry (2006, p. 114) “... the function of visual perception is to provide the perceiver with information about the objects, events and spatial layout in which the individual is required to think and act.” Gordon (2004) and Williams (1983) note that visual perception is a learnt phenomenon and many other researchers suggest that attention should be given to structured opportunities, activities and materials that will enhance and develop learners’ visual perception (Ayhan et al., 2015; Vlok et al., 2011; Yu, 2012). Todd (1993, p. 186) states “through this learning process, vision becomes seeing and the child acquires the essential skills that permits him to deal effectively with the spatial world.”

Clutten (2009) identified nine aspects of visual perception, the development of which she considers essential for the effective processing of visual information and learning, as well as academic performance and competency of learners. These nine visual perceptual aspects are; visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S). All of the above aspects of visual perception are considered in this study, as is the development of reasoning skills.

4. **EXPLORATORY TALK AND REASONING**

Exploratory talk, which was named as such by Barnes and Todd in 1975, is described by Monaghan (2004) as thinking aloud with others. It is a socio-cultural construct of learning that has recently gained much recognition in educational settings, especially in domains of mathematics (Barwell, 2005; Rabel & Wooldridge, 2013) and science (Dawes, 2004; Scott, 2008; Webb & Treagust, 2006). Exploratory talk requires learners to listen attentively to the speaker. The listeners are then expected to provide feedback to the speaker who may be
required to elaborate, clarify or even change his/her point of view. Exploratory talk not only assists one to sort out one’s thoughts, but provides a vehicle to assist two or more learners to solve a problem together (Mercer & Dawes, 2008). When exploratory talk occurs between learners, the talk is expected to be ‘symmetrical’ with each learner having equal status and potential for control (Light, Littleton, Messer, & Joiner, 1994).

Exploratory talk has been introduced successfully to learners of varying ages in the United Kingdom and multilingual Mexican and South African schools (Rojas-Drummond & Mercer, 2003; Rojas-Drummond & Zapata, 2004; Webb, Whitlow & Venter, 2016). However, research has shown that for exploratory talk to be effective and take root in classrooms, it has to be taught explicitly and practiced continually (Mercer, Wegerif, & Dawes, 1999). As such teachers need to be shown how to facilitate exploratory talk. Once they are competent they play a key role in providing opportunities, laying down ground rules and facilitating the talk (Monaghan, 2006).

Mercer and Dawes (2008) argue that for some learner’s school may be the only place where they can learn how to engage in focused, reasoned, critical discussion while they puzzle and grapple together, come up with different approaches, and discuss various strategies, thereby learning from one another. Clements and Sarama (2005) note that children become intensely engaged when several children are faced with a problem together while playing, and exploratory talk is well-documented for learners of 11+ years, but little has been said about facilitating this kind of discussion among younger learners. As such, an attempt was made in this study to get five Foundation Phase teachers (one in each of the five participating schools) who taught Grade 2 learners (who are usually between 8-9 years) to introduce exploratory talk when using the ‘6 Bricks’ approach. Ten of the over 300 ‘6 Bricks’ play activities were selected for introducing teachers to exploratory talk. The Raven’s Coloured Progressive Matrices
(RCPM) test was used to measure whether engaging in exploratory talk had any effect on their reasoning abilities.

5. PROBLEM STATEMENT

Poor performances in numeracy and literacy continue to be a problem for South African Foundation Phase learners (Department of Education, 2008). Research conducted by the Western Cape Education Department, identified visual perceptual problems as the underlying cause (Vlok, et al., 2011). Other studies, as early as that by Macdonald in 1991, have shown that many South African teachers are unable to instil the reasoning skills necessary for the development of higher-order cognitive skills in their learners, and there is little data to contradict her findings to date.

While, as mentioned earlier, it has been suggested by many that construction play provides concrete opportunities for the development of children’s visual perception, and that exploratory talk has been shown to improve children’s reasoning abilities, there is a paucity of empirical data to support these claims when attributed to children in middle childhood (for visual perception) and younger than eleven years old (for exploratory talk). While it has been specifically suggested that guided construction play using blocks provides concrete opportunities for the development of children’s visual perception, and that exploratory talk has been shown to improve children’s reasoning abilities, what is not known is if the ‘6 Bricks’ approach can be used to facilitate such developments. Considering the above, the problem that this study investigates is whether guided construction play using the ‘6 Bricks’ approach, both with and without the implementation of exploratory talk, develops Grade 2 learners’ visual perception and reasoning abilities.
6. **RESEARCH OBJECTIVES**

The primary and secondary objectives of this study are:

6.1 **Primary Objective**

The primary objective of this study is to investigate the possible effects that construction play (in the forms of guided play and guided play that employs exploratory talk) using the ‘6 Bricks’ approach has on the development of learners’ visual perception and reasoning abilities.

6.2 **Secondary Objectives**

The secondary objectives of the study are to:

- Investigate whether construction play (guided play) using ‘6 Bricks’ improves learners’ visual perception abilities,
- Investigate whether construction play (guided play that employs exploratory talk) using ‘6 Bricks’ improves learners’ reasoning abilities,
- Determine teachers’ perceptions regarding construction play using ‘6 Bricks’ and its effects, and
- Determine teachers’ perceptions regarding ‘6 Bricks’ with exploratory talk’ and its effects.

7. **RESEARCH QUESTIONS**

The principal research question in this study is:
Does construction play in the forms of guided play and guided play that employs exploratory talk using the ‘6 Bricks’ approach develop learners’ visual perception and reasoning abilities?

There are a number of sub-questions that are required to be answered in order to adequately answer the principal research question in this study. These questions are:

Sub-questions:

- Does guided construction play using the ‘6 Bricks’ approach develop learners’ visual perception?
- Does guided construction play that includes exploratory talk when using the ‘6 Bricks’ approach develop learners’ reasoning abilities?
- What are teachers’ perceptions of the effects of guided construction play using the ‘6 Bricks’ approach?
- What are teachers’ perceptions of the effects of facilitating exploratory talk during guided construction play using the ‘6 Bricks’ approach?

8. DESIGN AND METHODOLOGY

The research was conducted within a pragmatic paradigm using a mixed method approach (Creswell, 2005). Both quantitative and qualitative methods were used within a pre-test – intervention – post-test quasi-experimental design. Literature on construction play, visual perception, exploratory talk and reasoning abilities were researched to provide a theoretical basis for this study. The intervention, which employed the ‘6 Bricks’ (Duplo Bricks) approach developed by a team of Lego educators, required teachers to engage their learners in 5-10 minute activities three times a week over a period of 6 months. These teacher guided activities,
which use six different coloured Duplo Bricks (2x4 studs, Appendix A), aim at developing
visual perception. They also provide opportunities for longer activities, between 15-20 minutes,
for initiating exploratory talk to encourage learners to explore and communicate their thinking
and ideas.

The research study took place with fifteen volunteer Grade 2 teachers and their learners
in five purposively selected schools in Port Elizabeth, South Africa. The schools were chosen
because they are governmental schools with similarly diverse learner populations where the
language of learning and teaching (LoLT) is English. In each school, one teacher received
training on guided-play ‘6 Bricks’ activities, a second teacher received training on guided play
‘6 Bricks activities with exploratory talk’, while a third teacher received no training or ‘6
Bricks’ in order to provide a comparison group of learners.

Quantitative pre-post-test data were generated using computerised versions of the well
validated Visual Perceptual Aspects Test (VPAT) and the Raven’s Coloured Progressive
Matrices (RCPM) test. Testing was facilitated via staff and students of the NMMU Department
of Psychology. The data generated from the samples of 443 (VPAT) and 436 (RCPM) pre-post
matched pairs were normally distributed, which enabled parametric analysis to be undertaken
such as t-test, analysis of variance (ANOVA) and Cohen’s d measure of practical significance.
Data generated from the groups (guided play, guided play employing exploratory talk and the
comparison groups) were compared in terms of the development of visual perception and
reasoning abilities. All the experimental group teachers were interviewed to determine their
perceptions of the intervention strategies they employed. The interviews were transcribed,
inspected, categorised and analysed inductively to generate themes (Creswell, 2005). In
addition, teacher record sheets and classroom observation instruments were also used as a
means of collecting data. The qualitative findings were triangulated with the quantitative data generated.

Ethical aspects of a study which involves young children and teachers were considered and incorporated in the research design. The ethical requirements of the university and the Department of Education were also taken into account. These issues are elaborated in Chapter Three of this report.

9. OUTLINE OF THE THESIS

Chapter One provides a general introduction and orientation of the study and introduces the issues of play, visual perception, and exploratory talk. The research problem is formulated, the research question, design and methodology are presented, ethical issues are noted and a study chapter outline is provided.

Chapter Two provides a literature review and theoretical framework focusing on issues of play, construction play, visual perception, exploratory talk and reasoning abilities. Chapter Three explains the methodological framework and methods which were adopted when collecting and analysing the data. The sample, data gathering instruments, as well as issues pertaining to validity and reliability and ethics of the research process and procedures are also described.

Chapter Four focuses on the data generated in the study. These results are discussed in Chapter Five in light of the literature review in Chapter Two. The main conclusions drawn from this study and their implications and recommendations for further research are also argued in this chapter.
CHAPTER TWO
LITERATURE REVIEW

1. INTRODUCTION

This chapter provides an overview of three main issues, namely, play, visual perception and exploratory talk which form the theoretical framework of this study. Relevant literature pertaining to play, visual perception and exploratory talk are reviewed and discussed in detail. Topics relating to play, such as the definitions of play, and its descriptions, explanations, interpretations, characteristics and features are considered. The importance of play and its pedagogical value are interrogated. The categories of play, specifically construction play with ‘6 Bricks’ are explored. The impact of play on language and mathematical knowledge is examined and the ‘6 Bricks’ approach is described.

Issues pertaining to visual perception which include, the difference between sight and vision, the sequential development of visual perception, measures of visual perception and the Visual Perceptual Aspects Test (VPAT) are highlighted. The nine aspects of visual perception namely, visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S), are explained in detail.

Concepts of exploratory talk, such as the definitions of exploratory talk, the words most commonly associated with exploratory talk, and its benefits, explanations and ground rules are deliberated. The role of teachers and learners in exploratory talk, and the ability to work within a group are discussed. The impact that exploratory talk has on the development of reasoning
abilities and the Raven’s Coloured Progressive Matrices (RCPM) is interrogated. Finally, it is noted that these theoretical frameworks not only provide an explanatory purpose, but shape the conceptual framework within which this study is designed.

2. **PLAY**

Throughout history, and in all cultures, children have played and still continue to play (Callois, 1961; Csikszentmihalyi, 1979; Gauntlett et al., 2010; Hewes, 2007). Play is a universal phenomenon and is documented by the United Nations High Commission for Human Rights (1989) as a legitimate and specific right of childhood (Hewes, 2007; Smith, 2013) which is in addition to and distinct from children’s right to recreation and leisure (International Play Association, 2016).

Although play is easily recognisable in children’s activities, the plethora of descriptions and interpretations of play makes defining play in general elusive (Johnson, Christie, & Yawkey, 1999; Stagnitti, 2004; van Oers, 2013; Wardle, 2007). As early as 1985, Smith, Takhvar, Gore, and Vollsteadt (1985, p. 38) stated that the “definition of play is … in a muddle.” In addition, Bundy (2001, p. 89) noted “there is little agreement and much ambiguity about virtually every aspect of play, from its definition, to its purpose, to the ways in which it manifests itself.”

In spite of the elusive definition of play, play has always been of great interest to theorists, scholars of child development and education, psychologists, therapists and educators (Bodrova & Leong, 2003). Consensus on some of the basic characteristics and features of play have grown over the years (Stagnitti, 2004; van Oers, 2013). According to Sutton-Smith (1997) play follows two strands; (i) play revolves around the notion of flippancy or nonsensical behaviour, or (ii) play is a serious constructive thought-provoking, and perhaps most
importantly, a contemplative enterprise filled with aspects of learning, development and eventual progress.

Authors at the LEGO Foundation write:

To play is to engage. When we play, we pick up objects, ideas, or themes and do whatever we want with them. We turn them upside down and we experiment with them. We might arrive at something inspiring and amazing, but that is not necessarily the point. We play anyway – this is play for its own sake. (Gauntlett, et al., 2010, p. 9)

Bundy (2001, p. 5) describes play “as a transaction between the individual and the environment that is intrinsically motivated, internally controlled and free of many of the constraints of objective reality.” It is through play that children engage and interact in and with the world around them, which helps them develop new competencies that lead to enhanced confidence and the resilience they will need to face challenges in the future (Ginsburg, 2007; Hurwitz, 2003). In addition, “play promotes an optimum learning environment within which they can function and flourish naturally” (Bergen, 2009, p. 416).

Smith (2013, p. 1) describes play as “a spontaneous, voluntary, pleasurable and flexible activity involving a combination of body, object, symbol use and relationships.” Play reveals flexibility, positive affect, non-literality, intrinsic motivation, and preference of performance over outcomes (Smith, 2010). Wardle (1987) explains that play is self-directed. Children engage in play because they enjoy it. Once they get bored, they will stop playing or change their play. Children do not play for a reward (praise, money, or food) but play because they like it. Hewes (2007, p. 2) states:

Play is meaningful experience. It is also tremendously satisfying for children, a pursuit they seek out eagerly, and one they find endlessly absorbing. Anyone who has spent
any time watching children play knows they engage deeply and they take their play very seriously … Play is paradoxical – it is serious and non-serious, real and not real, apparently purposeless and yet essential to development. It is resilient – children continue to play in the most traumatic of situations – and yet fragile – there is increasing evidence that play deprivation has a damaging impact on development. (Hewes, 2007, p. 2)

Characteristics and features of play proposed by other theorists and authors (Bracegirdle, 1992; Bundy, 1997; Burghardt, 2011; Goodman, 1994; Parham & Primeau, 1997; Pellegrini & Galda, 1993; Rubin, Fein, & Vandenberg, 1983; Smith et al., 1985; Stewart et al., 1991) include (i) play is safe, fun, pleasurable, unpredictable, flexible and rewarding, (ii) play transcends reality as well as reflects reality, (iii) play is spontaneous and involves non-obligatory active engagement, (iv) play is controlled by the player, (v) play is more internally than externally motivated, (vi) play is concerned with process rather than product, (vii) play is non-literal, and (viii) play is often repeated. In addition, play and learning expert, Tina Bruce (2005), listed features which she thinks captures the nature of play. These include:

- play can be solitary,
- play can be initiated by a child or an adult,
- play can be in partnership or groups, with adults and/or children, who will be sensitive to each other,
- play is about possible, alternative worlds, which lift players to their highest levels of functioning. This involves being imaginative, creative, original and innovative,
- play is about participants wallowing in ideas, feelings and relationships. It involves reflecting on and becoming aware of what we know – ‘metacognition’,
➢ play actively uses previous first-hand experiences, including struggle, manipulation, exploration, discovery and practice,

➢ play is an integrating mechanism, which brings together everything we learn, know, feel and understand.

The descriptions, explanations and interpretations above bear testimony to the difficulty of defining play, which is probably best encapsulated by Ginsburg (2007, p. 183) who concludes that “play is a simple joy that is a cherished part of childhood.”

2.1 Importance of play

Despite the multitude of literature emphasising the importance of play in childhood, opportunities for children to play continue to decline rapidly with play time either being limited or entirely eliminated (Bergen, 2009; Bodrova & Leong, 2003; Gauntlett et al., 2010; Ginsburg, 2007; Lockhart, 2010; Staempfli, 2009; Wardle, 2007). Hewes (2007, p. 1) affirms “play is persistently undervalued, and children’s opportunities for uninterrupted free play – both indoors and out – are under threat.” Evans (1995) and Frost (2006) ascertained that the past several decades has witnessed a dramatic change to the physical and social environments of children in the Western world. Staempfli (2009) explains that the reasons for these changes are diverse and multi-layered.

One reason cited is that parents are increasingly concerned about the safety of their children in outdoor play environments (Blinkert, 2004; Clements, 2004). Another reason is the priority given to the early acquisition of academic skills (Zigler, 2004) and the pressure to accelerate young children’s academic learning (Lockhart, 2010). Bodrova and Leong (2003) report that the growing demands for teacher accountability and measurable outcomes are pushing play to the periphery of the curriculum. Teachers reported that they must increasingly
defend the use of play in their classrooms to administrators, principals, parents, and teachers of higher grades.

In addition, advocates of academically rigorous programmes for young children view play and learning as mutually exclusive, and call on teachers to spend more time on specific academic content such as literacy and numeracy via direct teacher instruction (Bodrova & Leong, 2003; Hewes, 2007; Wardle, 2007). However, Bergen (2002) maintains that when children are properly supported in their play, the play does not take away from learning but contributes to it.

Lately, there is a heightened awareness regarding the importance of children's play with paediatricians, psychologists of learning and development, educational psychologists, occupational therapists and educators acknowledging its importance in childhood (Gauntlett et al., 2010; Ginsburg, 2007; Hewes, 2007; Lockhart, 2010; Stagnitti, 2004; Wardle, 2007). Young adults were asked to recall their most salient childhood play experiences. They recalled rich and joyous accounts of play between the ages of eight-to-twelve years (Bergen & Williams, 2008). At a recent workshop conducted by the Centre for Science and Policy (2015) regarding the importance of play in middle childhood, participants expressed their view that childhood has become increasingly structured. This workshop emphasised the recognition that opportunities to play in middle childhood are equally important as they are in early childhood (Centre for Science and Policy, 2015), which supports Bergen's (2009, p. 416-417) stance that play is the “medium of learning at all ages because many qualities of play enhance learning processes.”
2.2 Pedagogical value of play

Play is an all-encompassing activity (Canadian Association of Occupational Therapists, 1996), important for optimal child development (Ginsburg, 2007). It has an intrinsic value in childhood and is associated with immediate, short-term and long-term term benefits (Hewes, 2007; Smith, 2013). Gauntlett et al. (2010, p. 15) of the LEGO Foundation report “today it is almost universally accepted by developmental psychologists that children develop and learn principally through play.” Johnson and Patte (2013, p. 2) affirm that “play is associated with the being and becoming of the whole child - characterised by different but interrelated developmental dimensions/domains … play actions and thoughts of young children are connectable to micro- and macro-contextual factors.” These developmental domains include the physical, social, emotional, cognitive, intellectual, linguistic, and creative domains (Ferrara et al., 2011; Ginsburg, 2007; Hewes, 2007; Smith & Pellegrini., 2013; Wardle, 2007). In addition, play provides stimulation for proper perceptual, motor and neural development (Gauntlett et al., 2010).

Learning and cognitive development are seen as active processes by renowned theorists such as Piaget, Vygotsky, and Bruner (Donald et al., 2010). One of the cognitive domains that develop during middle childhood is an increase in memory and attention which is primarily due to greater efficiency in encoding, sorting and retrieving information. Another is the acquisition of memory strategies. One such strategy is rehearsal, which is the process of repeating to oneself the material that one is trying to memorise; such as a word list or a phone number (Lightfoot, Cole, & Cole, 2009).

Research indicates that play is important to healthy brain development and has also been found to yield profound effects on brain development (Frost, 2006; Gauntlett et al., 2010; Shonkoff & Phillips, 2000; Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004). While Piaget
(1962) and Vygotsky (1978) were among the first to link play with cognitive development, recent brain research shows that integrating play is very important to development. Wardle (2007, p. 3) recognises Shore’s (1997) assertion that:

Play provides a natural integration between all the critical brain functions and learning domains that are often missing with discrete teacher instruction. Piaget explained that during play, children are presented with numerous opportunities and different materials to explore their environment which assists them to assimilate and accommodate new information. Recent brain research shows that this integration is very important to development. (as cited in Wardle, 2007, p. 3)

Experts agree that play provides the foundation for learning (Lockhart, 2010). Osborne and Brady (2001, p. 511) hold that “learning is a component of playing, and playing is a component of learning, and both taken together constitute a process of coming to know. They are aspects of one epistemology.” Wardle (2007, p. 5) adds “play is, in fact, the most efficient, powerful, and productive way to learn the information young children need.” Researchers reviewed numerous studies on play and found evidence that play contributes to advances in verbalisation, vocabulary, language comprehension, attention span, imagination, concentration, impulse control, curiosity, problem-solving strategies, cooperation, empathy, and group participation (Smilansky & Shefatya, 1990).

Additional benefits fostered by play are creativity, adaptability, flexibility in thinking, problem-solving, communication, self-awareness, feelings of competence and self-confidence, a willingness to tolerate uncertainty, take risks, collaborate and negotiate with others, a sense of control over their environment and sensory-motor functions (Centre for Science and Policy, 2015; Canadian Association of Occupational Therapists, 1996; Hewes, 2007; Wardle, 2007).
Most importantly, is the enjoyment and positive affect that play exudes where children are seen smiling and laughing (Smith & Pellegrini, 2013).

2.3 Types of play

Mellou (1994) categorised play into two theories; classical theories and modern theories. Classical theories of play originated in the nineteenth century and tried to explain the existence and purpose of play. Modern theories of play were developed after the 1920s and attempted to explain the role of play in child development. An example of modern theory of play are the ‘cognitive development theories of play,’ founded by Piaget (1962) and Vygotsky (1997; 1966). These modern theories of play recognise play as a cognitive process and a voluntary activity. They are based on the premise that play contributes to cognitive development, problem-solving and creative thought. In addition, they affirm that play develops innovation, flexibility, enhanced problem-solving and adaptation (Stagnitti, 2004).

Many different forms of play in childhood have been identified and described which include; exploratory play, object play, construction play, physical play (sensorimotor play, rough-and-tumble play), dramatic play (solitary pretence), socio-dramatic play (pretence with peers, also called pretend play, fantasy play, make-believe, or symbolic play), games with rules (fixed, predetermined rules) and games with invented rules (rules that are modifiable by the players). During childhood, these forms of play evolve and very often play is not confined to one form but rather a combination of different forms of play (Hewes, 2007).

According to Wolfgang, Stannard, and Jones (2003), the many different forms of play can be grouped into three large categories: (i) sensori-motor play, which involves large and small motor activities; (ii) symbolic play, which involves representational abilities and includes the fantasy play of socio-dramatic play; and (iii) construction play, which involves symbolic
product formation with LEGO, blocks, carpentry or similar materials (Piaget, 1962; Smilansky, 1968; Wolfgang & Wolfgang, 1999). This study focuses on construction play using the ‘6 Bricks’ approach, and its possible effects on the development of visual perception and reasoning abilities of Grade 2 learners.

2.4 Construction play

Gauntlett et al. (2010) explain that by the age of four years, building, making and constructing behaviours emerge, and that the greatest incidence of construction play is observed in children between the ages of 3-8 years engaging in construction play by themselves and in groups (Hewes, 2007). In general, construction play involves children using objects with a predetermined shape and size to create a product that represents something else (Sarama & Clements, 2009; Stannard et al., 2001). These objects include puzzles, cars, dolls, building blocks, DUPLO or LEGO (Smith & Pellegrini, 2013; Stannard et al., 2001).

Educators as early as Pestalozzi (1898) have documented the playing with block-like objects as construction play (Wolfgang et al., 2003). LEGO, made from plastic with peg and hole connectors (studs), is seen as a more modern version of constructional block play (Wolfgang et al., 2003). Paediatrician, Ginsburg (2007, p. 187), emphasises the educational value of playing with blocks. He refers to blocks as “true toys”, explaining that blocks require children to use their imagination fully. LEGO and blocks are known as “countable play objects”, shown to engage children for lengthy periods of time and also contribute to their intellectual development (Ness & Farenga, 2007, p. 209). Playing and constructing with blocks, DUPLO or LEGO has been shown to offer a play context which improves learning (Ferrara et al., 2011). Sarama and Clements (2009) believe that the benefits of playing with blocks and LEGO are far-reaching and numerous. Pirrone et al. (2015) explain:
When children manipulate and assemble pieces, building-block play furnishes opportunities to learn and practice visual perception along with gross and fine motor skills. As children handle blocks, they become mentally active, learning to interpret and process sensory information (p. 153).

Block play also contributes to memory development and verbal, perceptual, and quantitative skills (Ness & Farenga, 2007). By playing with blocks, children internalise the physical attributes of the blocks and begin to establish relationships between them (Pirrone et al., 2015). Constructing with the blocks allows them to experiment, finding out which combinations work and which do not (Wardle, 2007). They learn to build mental images, plan, reason, and connect ideas (Sarama & Clements, 2009). They also learn and internalise the meaning of mathematical and scientific concepts such as size, shape, length, weight, capacity, and balance (Piaget, 1945; Pirrone et al., 2015; Reifel, 1984).

Constructing with blocks develops physical skills (Gauntlett et al., 2010), enhances creativity (Smith, 2013), stimulates problem-solving skills, logical thinking and conceptual understanding (Smith & Pellegrini., 2013; Gauntlett et al., 2010; Hampton, Passanisi, & Jonsson, 2011), increases children’s mathematics, science, and general reasoning abilities (Kamii, Miyakawa, & Kato, 2004), and provides the foundation for later literacy learning (Hanline et al., 2010). Through construction play, children develop perseverance, a positive attitude towards challenge (Gauntlett et al., 2010), and a sense of accomplishment (Wardle, 2007).

Playing and constructing with blocks allows children to play directly with spatial concepts thereby developing spatial abilities which have been found to be closely linked to a number of academic achievements later in life (Humphreys, Lubinski, & Yao, 1993; Shea, Lubinski, & Benbow, 2001). Wardle (2007, p. 2) reports that children “who are comfortable
manipulating objects and materials also become good at manipulating words, ideas, and concepts.” Research shows that adults who have gone into scientific, mathematical, and engineering fields were often great construction players as children (Bergen, 2009).

2.5 Play and language

Research suggests that during block play, children engage in spatial language (Ferrara et al., 2011) which is directly related to spatial cognition (Pruden, Levine, & Huttenlocher, 2011). Neuman and Roskos (1992) maintain that words embedded in playful contexts are learned better and faster by children. Block play allows children to play directly with spatial concepts which assists them to develop and understand representations of spatial relationships between objects such as into, out, together, on top, beside, and under (Gentner & Loewenstein, 2002; Reifel, 1984). Children learn spatial vocabulary as well as other words necessary for reading by playing with, and manipulating objects such as blocks or LEGO (Copley, 2000). Spatial vocabulary include (i) location/position words such as on, off, in front of, behind, top, bottom, above, below, (ii) movement words such as up, down, toward, away from, forward, backward, and (iii) distance words such as near, far, close to, far from, shortest, longest. Children from low socio-economic households face contextual challenges in acquiring language, but block play can be seen as a powerful educational tool in their acquisition of spatial language (Case, Griffin, & Kelly, 2001; Whitehurst, 1997).

During block play, children pay close attention to shape and position (Ferrara et al., 2011) which assists them to distinguish between letters of the alphabet. Copley (2000, p. 106) writes “even distinguishing between letters of the alphabet involves attention to shape and position.” Verdine et al. (2014, p. 9) claim “current evidence strongly suggests that spatial training and additional spatial language exposure will work to improve spatial cognition and have ancillary benefits for mathematical achievement.”
2.6 Play and mathematics

According to Seefeldt and Wasik (2006, p. 250) “In order to have opportunities to learn math, children need first-hand experiences related to math, interaction with other children and adults concerning these experiences and time to reflect on the experiences.” Boggan, Harper, and Whitmire (2010, p. 2) further explain “educational research indicated that the most valuable learning occurs when students actively construct their own mathematical understanding, which is often accomplished through the use of manipulatives.” Children should therefore be provided with a variety of materials/concrete objects to manipulate (e.g. blocks or LEGO) if they are to construct mathematical knowledge.

Playing with spatial toys such as blocks or LEGO have a significant influence on the development of spatial skills (Brosnan, 1998; Caldera et al., 1999; Ginsburg, 2007; Ness & Farenga, 2007). Spatial skills, such as deciding whether a block should go over or under another block, or whether it is aligned or perpendicular, are important for success in science, technology, engineering and mathematics (STEM) (Bergen & Fromberg, 2008; Lubinski, 2010; Newcombe, 2010; Pirrone et al., 2015; Uttal et al., 2013; Verdine et al., 2014). Studies reveal that the cognitive structures that develop through LEGO or block play become evident during middle and high school when the mathematics curriculum requires higher abstract mathematics such as geometry, trigonometry and calculus (Hanline et al., 2010; Wolfgang et al., 2003; Wolfgang et al., 2001). Verdine et al. (2013, p. 3) contend that children “with good spatial skills rise to the top in mathematics as the curriculum becomes more complicated and incorporates more spatial elements.”

Sylva, Bruner, and Genova (1976) maintain that block play lays the foundation for logical mathematical thinking, scientific reasoning, and cognitive problem-solving. Research conducted by Ness and Farenga (2007) confirm that environments which consist of blocks or
LEGO contribute to children’s arithmetic, spatial and geometric development. The conventions for written mathematics and the ability to understand mathematical symbols rely heavily on spatial skills (Cheng & Mix, 2014), while geometry involves shape, size, position, direction and measurement (Copley, 2000).

According to Verdine et al. (2013), LEGO bricks have pips/studs that attach the pieces together. If children are to correctly place these pieces, they require counting skills and an understanding of concepts such as units and measurement. Affording children opportunities to play and practice with LEGO “may provide an early analogue for learning explicit measurement concepts and for understanding discrete units, helping build a more concrete link between number magnitudes and number language” (Verdine et al., 2013, p. 9). In addition, counting and measuring with blocks can be seen as a mechanism by which spatial experience influences early mathematics skills (Verdine et al., 2014).

Spatial skills play a fundamental role in improving mathematical skills (Mix, Moore, & Holcomb, 2011; Newcombe, 2010). Mathematical skills such as comparing, counting, classifying, estimating, measuring, ordering, patterning, magnitude, using fractions, part-whole relations, visualisation, symmetry, transformation and balance could also be promoted through block play (Casey & Bobb, 2003; Sarama & Clements, 2009; Wolfgang et al., 2001). In a recent study conducted by Grissmer et al. (2013), kindergarten and first-grade children were provided with visuospatial toys (LEGO and pattern blocks) that required them to copy model designs. The activities were not specifically mathematical in nature but were found to improve children’s spatial and mathematical skills.

While playing with blocks children pay close attention to the colours, shapes, sizes and positions of the blocks (Ferrara et al., 2011), and may even compare the sizes of the towers and structures they build (Clements & Sarama, 2005; Leeb-Lundberg, 1996). They also become
aware of depth, width, length, weight, capacity, balance, symmetry, shape, and space (Ginsburg, 2007; Hirsch, 1996; Pirrone et al., 2015). Playing with three-dimensional figures (e.g. blocks or LEGO) enables children to see the relationships between the number of faces, edges, and vertices. When asked to group items according to shape or geometric features, they develop a skill which is fundamental to data collection (Copley, 2000). Although block play is beneficial for all children, Park et al. (2008, p. 158) remark that “children of families with more limited economic resources might benefit more from their mathematics learning through block play.” Clements and Sarama (2005) contend that certain toys, such as Duplo and Lego bricks, are so beneficial, that all children should play with them over and over again. ‘6 Bricks’ is thought to fit this category, whereby teachers can afford learners multiple opportunities to engage in structured, guided, goal-directed play.

2.7 The ‘6 Bricks’ approach

LEGO is the invention of Danish carpenter Ole Kirk Christiansen. He named his firm LEGO which is derived from the Danish words leg and godt, which means to play good. Forbes magazine voted LEGO bricks the best toy of the 20th century. Since 1958, various toys and building bricks have been manufactured in various shapes and sizes. The most common dimensions of the building bricks are the 2x2 and 2x4 stud bricks. Mathematicians, through the means of computers, calculated that 24 different figures can be constructed from two 2x4 stud bricks, while 915 103 756 different figures can be constructed from six 2x4 stud bricks. The construction possibilities with LEGO building bricks are numerous (Rudec, 2007).

Care for Education (CfE), based in Johannesburg, South Africa, is a non-profit organization that incorporates play-based learning into early childhood and primary school settings. CfE is a partner of the LEGO Foundation and receives educational materials from them which are then distributed to schools and organizations, especially targeting those with
poor and vulnerable children (such as Atteridgeville, a large township located between Johannesburg and Pretoria, South Africa). CfE does not just hand out these materials, but trains and equips teachers to incorporate these materials into their children’s everyday learning. In doing so, they intend to improve educators’, schools’ and communities’ understanding of and ability to implement play-based learning (Results for Development, 2016).

Among the educational materials received by CfE from the LEGO Foundation are the Charity Boxes. These boxes are packed by volunteers and retired LEGO employees and contain a variety of new or unused bricks, which CfE distributes and trains teachers to use. However, after many years, CfE realised the magnitude of the difficulties these teachers face. Not only must they try to manage many children in limited classroom space, but also try to maintain children’s attention and provide a meaningful learning environment with hundreds of LEGO pieces scattered across the floor. CfE experimented with providing less LEGO, still ensuring that every child has an equal set. This experiment became the ‘6 Bricks’ concept (Results for Development, 2016).

Brent Hutcheson, the director of CfE, is the founder of the ‘6 Bricks’ approach. Below is his explanation (Hutcheson, personal communication, August 06, 2014):

In 2013, after experimenting over a 5 year period with numerous educational manipulatives (mainly LEGO educational products) in 25 schools in Atteridgeville (a township outside Pretoria), I was looking for a more scalable, cost effective and simpler solution for schools in South Africa. I knew already that as a country we had to go back to basics. I felt that perceptual development was poor and children were missing out on crucial developmental areas. At the time I read up as much as I could around the relationship between concrete manipulation, learning and development. I was interested in how perceptual and motor skills could be developed, what activities
and exercises could assist and how to keep the activities short, yet engaging. My research indicated that children had to build outside their field of vision within 5 steps (5 manipulatives) in order to remain engaged. I found that 5 DUPLO bricks were the perfect size to do this, however this did not easily provide me with a middle point - and I knew I needed this for children to be able to cross the midline and for bilateral integration exercises. The 6th brick solved the problem - and hence the 6 Bricks idea was conceptualized.

The first 4 colours chosen were easy - they were the four basic LEGO brick colours; (red, green, blue and yellow) and I knew they would be easy to source. We didn't have much choice with regards to other colours - didn't want to use black or white - and after discussing with Nancy and Linda (my colleagues), it was decided to use two similar colours (light blue and dark blue) to assist with language concept development. And in the end we decided to use orange as our 6th colour based on the fact that it too was easier to source.

I presented Nancy and Linda with a handful of ideas/activities that could be done with 6 Bricks and tasked them with developing a whole lot more. Initially we thought it would be great if we had an activity for each school day of the year (± 221 activities). Our first book had only 30 activities - our latest has over 300. Whilst working on and developing the new ideas, we continued the research into using manipulatives and ended up adding so much more. The activities are designed to be repeated daily and develop mental readiness in which the child focuses and concentrates for a limited period of time. These short activities are teacher-guided, but open-ended with plenty of opportunities for children to control and direct their own learning. We now include
activities that promote the development of social and emotional areas, language and mathematics, group games and activities, board games and executive functioning skills.

The ‘6 Bricks’ activities are thought to develop sensory and perceptual skills which include; tactile discrimination, gross and fine motor skills, memory skills, and auditory and visual perception (Hutcheson, Frank, & Smith, 2014).

3. VISUAL PERCEPTION

Vision is mankind’s most dominant sense and should not be mistaken for eyesight. Eyesight is a prerequisite for vision. We can either see or cannot see but we cannot learn nor be taught to see (Harris, 2016; Kranowitz, 2005). The eye is the receptor organ for sensory input which moves in a series of quick movements, called saccades and pauses to take in visual information during fixations (Warren, 1993). Unlike eyesight, we are not born with vision but rather it is developed and learnt over a period of time (Cheatum & Hammond, 2000; Gordon, 2004).

Carey (2006, p. 1) defines vision as “knowing what is where by looking.” Brockett (2004) describes vision as the ability of the brain to organize, interpret and derive meaning from the information that comes to it through the eyes. Harris (2016) explains that vision is the entire process whereby an individual understand what he/she sees. Vision also helps us make sense of information received through the other senses, namely; touch, taste, smell and hearing (Gregory, 1966; Tilstone et al., 2004).

Kirk, Gallagher and Anastasiow (2000) contend that children interpret the environment through the significance of what is seen. Research indicates that 80% of the information we take in comes through the eyes, 80% of visual processing is responsible for what we see and 20% is responsible for where and how we see, and 75-90% of classroom learning depends on
vision (Kranowitz, 2005). Vision is therefore a fundamental part of the developmental process of visual perception (Clutten, 2009).

Perception occurs in the brain and is a developmental process which matures with age and experience (Clutten, 2009). Perception is “stimulus driven” (Loikith, 1997, p. 197). The process of ‘taking in’ one’s environment is referred to as perception (Advanced Vision Therapy Center, 2016). Erhardt and Duckman (2005) define perception as the reception and interpretation of a stimulus received from the environment. Rookes and Willson (2000, p. 1) describe perception as a process which involves “the recognition and interpretation of stimuli that register on our senses.” Dednam, (2005a, p. 370) refer to perception as “the ability to give meaning to information gathered by the senses.” Bergh and Theron (2003, p. 104) explain that “perception is not possible without sensation. Sensation entails stimulation of the sense organs, while perception entails the selection, organisation and interpretation of sensory stimulation.” Perception is therefore a selective process by which we interpret and give meaning to external factors, making us aware of the world around us.

Tilstone et al. (2004) state that there is a difference between perception and cognition and that it is difficult to indicate where perception ends and where cognition begins. They further explain that understanding, knowing, remembering and problem-solving are cognitive processes, but perception itself requires that information received through the senses (e.g. vision) be processed. Perception is therefore important to consider because of its primacy for the cognition process.

Visual perception is one of the major perceptual senses in human life (Yu, 2012). It plays a fundamental role within the academic environment, enabling learners to acquire reading, writing, spelling and mathematical proficiency (Clutten, 2009). It is also required to
successfully carry out most activities of daily living, such as dressing, brushing teeth, cooking and driving (Richmond, 2010).

A review of literature reveals that there are various definitions for the term visual perception. According to Williams (1983, p. 73) visual perception is “a pick-up and analysis of sensory information from the external environment through the use of the visual mechanism.” Kulp (1999) defines visual perception as the process of organising and deciphering visual information. Warren (1993) maintains that visual perception commences with the visual stimulus and subsequently proceeds through higher cognitive processes. Gardner (1996) agrees that visual perception is the capacity to interpret or give meaning to what is seen. It includes recognition, insight, and interpretation at the higher levels of the central nervous system. Loikith (1997, p. 218) states that “visual perception is a dynamic cognitive effort that at once involves memory, strategic knowledge, short-term memory and attention, to satisfy a visual task, demand or goal.” This visual task may be anything from tying one’s shoe laces to reading or writing.

Other definitions of visual perception are; an ability to gather information (Stern & Robinson, 1994), an intelligent activity of the mind (Enser, 1995), an observable behaviour in children (Bilal, 2000), a union of personal and sensory experience (Barat, 2007), established responses to visual stimuli (Ayhan et al., 2015), or used to create meaning from the observations of the environment made during motion and in stable positions (Vlok et al., 2011). The many definitions of visual perception attest to its importance. According to Beery and Beery (2006, p. 10) “visual perception is probably best defined as the interpretation of visual stimuli, the intermediate step between simple visual sensation and cognition.”

Clutten (2009) writes that Hammill, Pearson and Voress (1993) ascertained that the receptive process of visual perception can be separated into three specific levels:
➢ sensation: which is simply the awareness of visual stimulus,

➢ perception: which deals with concrete and non-symbolic properties (shape, size, colour, texture, position) of visual stimuli, and

➢ cognition: which includes diverse mental processes of thinking, meaningful language or problem-solving.

Richmond (2010) elucidates these three specific levels by means of the following example where a learner sees the written form of language (sensation), interprets the symbols (perception), and is able to read with meaning (cognition). Clutten (2009, p. 20) summarises visual perception:

Visual perception is a conscious, yet subjective and selective internal perceptual-cognitive process. This process involves an active identification, interpretation, categorisation and assigning of meaning to registered external factors. Meaning is gained when the perceiver mentally attends to and selects visual stimuli to focus on the retina of the eye. These stimuli are then processed by the visual system before being analysed by diverse brain centres.

Visual perception is sometimes considered a passive way of absorbing information (Yu, 2012). However, research indicates that it is an active and constructive process (Cheatum & Hammond, 2000; Groffman, 2006; Wade & Swanston, 2001; Williams, 1983) whereby visual information is extracted from the visual environment in a selective, active and efficient way (Richman, 2006).

According to Yu (2012), visual perception adjusts and refines itself as children develop new concepts and knowledge. The more children incorporate new knowledge, the more they enrich their conceptual understandings. Ayhan et al. (2015) agree that conceptual development
accompanies the development of visual perception and explain that it is important for children to conceptualise the environment they perceive visually in order to make sense of it.

3.1 Development of visual perception

Glass (2002, p. 1) mentions “the visual system is our most complex sensory system, but functionally the least mature at birth” and child development researchers acknowledge that there is an association between children's growth and visual perception (Arnheim, 1974; Gardner, 1994; Piaget & Inhelder, 2000). The development of visual perceptual aspects begin at birth (Schneck, 2005), then develop rapidly and significantly from approximately three-six years of age (Kellerman & Arterberry, 2006; Williams, 1983), and continue to develop, consolidate and become refined until about the age of 11 (Rosner, 1993). In turn, Warren (1993) maintains that the development of visual perceptual occurs from 2 months to 12 years of age.

Piaget maintains that during the sensorimotor stage (birth to two years) infants gain knowledge through looking, touching and holding objects. However their ability to understand symbols is limited. During the preoperational stage (two-seven years) children’s language, thinking, imagination and problem-solving develop faster because they are able to work with images and symbols. Then, during the concrete operational stage (seven to eleven years) children gradually become less egocentric and less dominated by perceptions. They are able to generalize things learnt in one situation to other situations. For example, the letter b remains a b whether it is lower case, upper case, printed or handwritten (Bergh & Theron, 2003; Donald et al., 2010; Tilstone et al., 2004).

Development is “based on children’s active engagement with and exploration of their physical and social world” (Donald et al., 2010, p. 53). While experiencing physiological and psychological development of visual perception, children sharpen their visual experience,
develop concepts, and attach meaning from what they have seen and learned. For example, the more a child learns and incorporates new knowledge, the more he/she is able to enrich concepts and better recognize visual symbols, such as mathematical or linguistic symbols (Yu, 2012).

While authors (Bergh & Theron, 2003; Schneck, 2005; Williams, 1983) agree that the process of visual perceptual development is relatively sequential, Borsting (2006) and Van Romburgh (2006) remark that children may not be presented with equal opportunities to develop their visual perception. Visual perceptual development may be hindered, altered or changed at any stage of development, sometimes due to a lack of appropriate stimulation, emotional trauma, possible injury or illness, or other unidentified causes (Brockett, 2004; Clutten, 2009).

The sequence of visual perceptual development is closely linked with age (Clutten, 2009; Schneck, 2001; Vlok et al., 2011; Wait, 2004; Wittaus, 2002). Figure 2.1 shows the development of the primary visual perceptual aspects, namely; visual form constancy, visual figure-ground, position-in-space and visual spatial-relationships.

Hindrances, delays or limitations to the development of any visual perceptual aspect can have a negative effect on a number of occupational performance and functional areas for children. Some of these include; reading, writing, spelling, mathematics and activities of daily living (Brown, Rodger, & Davis, 2003; Clutten, 2009).
As noted earlier, researchers conclude that visual perception is the foundation for optimal learning (Groffman, 2006; Vlok et al., 2011) and facilitate a learner’s ability to read, write, spell and complete mathematical computations (Flax, 2006; Kulp, 1999; Loikith, 1997; Richmond, 2010; Vlok et al., 2011; Woodrome & Johnson, 2009; Yu, 2012). Theorists and researchers have been identifying aspects of visual perception, which are seen as separate, yet inter-related entities (Frostig, Lefever, & Whittlesey, 1966). Frostig et al. (1966) identified and included five aspects; eye-motor coordination, constancy of form, position-in-space, figure-

Kavale (1982) studied the correlation between visual perceptual skills and reading achievement and selected the following; visual discrimination, visual memory, visual spatial-relationships, visual closure, visual association, visual-motor integration, visual-auditory integration and figure-ground discrimination. Erhardt and Duckman (2005) maintained that visual perceptual processes include aspects of visual discrimination, visual form constancy, visual memory, visual sequential memory, visual figure-ground, visual spatial-relationships and visual closure.

Within the South African context, Scott (2003) claimed that the following visual aspects; namely discrimination, foreground/background discrimination, memory, analysis, synthesis and closure, play a vital role in determining school readiness abilities. Dednam (2005a) contended that visual discrimination, form consistency, visual memory, visual sequence, visual figure-ground perception, visual closure, visual analysis and synthesis and spatial orientation are the most crucial visual aspects which will enable learners to perform satisfactorily.

Most recently, Clutten (2009) identified nine aspects which she included in the design and development of a Visual Perceptual Aspects Test (VPAT); namely, visual discrimination, visual form constancy, visual memory, visual sequential memory, visual spatial-relationships,
position-in-space, visual closure, visual figure-ground, visual analysis and synthesis. A detailed
discussion of each aspect follows.

3.2.1 Visual Discrimination

Visual discrimination is “the ability to differentiate, to varying degrees of precision,
similarities or differences in the characteristics, arrangement, sequences and/or organization of
single or groups of visual stimuli” (Williams, 1972 in Williams, 1983, p. 81). Gardner (1996)
defines visual discrimination as the ability to match or determine exact characteristics of two
forms when one of the forms is among similar forms. Visual discrimination has also been
declared as the ability to perceive sensory information, and then recognise similarities and
differences between symbols, letters, words, shapes, forms, objects, sizes, colours, patterns,
and pictures (Edwards, 1987; Grove & Haupfleisch, 1978; Ho, Chung, & Lin, 2012; Kirk et
al., 2000; Kranowitz, 1998; Levine, 1991; Stories and Children, 2016; Todd, 1999; Your
Therapy Source, 2013).

Visual discrimination is required to see small visual details and can be described as
‘paying attention to detail’ (Le Roux, 2016b). Cheatum and Hammond (2000) and Schneck
(2010) explain that during the process of discriminating between similarities and differences,
learners will use recognition, matching and sorting skills (Schneck, 2001) and categorisation
of the information (Todd, 1993). Visual discrimination will develop as the ability to attend to
information and to memorise the information increases (Vlok et al., 2011).

Children who struggle to visually discriminate may have difficulty matching clothing,
socks, or cutlery, especially when the differences are subtle (Le Roux, 2016b). Learners who
struggle to visually discriminate may have difficulty distinguishing the number of humps of
the letters m and n (Clutten, 2009) or whether a letter is a lower case or an upper case (Stories
and Children, 2016). They may also struggle to see the differences and discern between similar
looking letters like h/n, or b/d, or p/q, similar looking words like car/cat, or not/hot, or bad/bed, similar looking numbers like 1/7, or 3/8, or 6/9, or 12/21, and similar looking shapes like a square and rectangle, or a circle and an oval (Clutten, 2009; Dednam, 2005a; Le Roux, 2016b; Richmond, 2010).

Visual discrimination is especially important to learn how to read and write (Your Therapy Source, 2013). Glass (2002, p. 3) contends that “the highly complex task of reading involves interpretation of meaning from a finite set of visual elements (26 letters) that represent sounds arranged into words to convey meaning.” Kavale (1982) and Kavale and Forness (2000) reported that visual discrimination appears to be the most useful visual skill indicator of future reading ability. A study conducted by Woodrome and Johnson (2009) investigated the relevance of visual discrimination to the learning-to-read process. Their results showed a specific relationship between visual discrimination and lowercase letter identification abilities. Learners who demonstrated stronger visual discrimination abilities, performed better on the lowercase identification task. This implies that learners must first learn to discriminate between letters before they can read words. Retief and Heimburge (2006) concluded that visual discrimination is essential for reading, writing, spelling and mathematics.

3.2.2 Visual Form Constancy

Matlin (1992) explains that we move around in a stable world in which objects do not change haphazardly, but instead retain their characteristics under many different viewing conditions. This can be explained by the phenomenon called constancy, which is the tendency for qualities of objects (such as size and shape) to stay the same, despite changes in the way we view the objects. Gardner (1996) defines visual form constancy as the ability to see a form, and to be able to find that form, even though the form may be smaller, larger, rotated, reversed and/or hidden.
Hammill et al. (1993) refer to form constancy as the ability to recognise dominant features of forms when they appear in different sizes, colours, shadings, textures or positions. Dednam (2005a) agrees that visual form constancy is the ability to identify an object on the basis of its form. Schneck (1996) described form constancy as the recognition of forms and objects as the same in various environments, positions and sizes. Ho, et al. (2012) concurs that visual form constancy is the ability to recognise original objects regardless of changes to size, colour, line, shade, background, brightness, direction, shape or other properties.

Bergh and Theron (2003, p. 112) identified three different constancies, namely:

(i) size constancy: means that an object remains the same size despite changes in the distance between the viewer and the object. For example, whether a bus is close or two kilometres away, we still perceive it as a large object,

(ii) shape constancy: means that an object remains the same shape despite changes in its orientation towards the viewer. For example, a compact disc is not distorted into an oval if we view it from an angle, we still perceive it as round, and

(iii) lightness and colour constancy: means that an object remains the same lightness and colour despite changes in the amount and colour of light falling on it. For example, a pair of black shoes will continue to look black whether in bright daylight or artificial light.

Visual form constancy has also been defined as the ability to recognize and label objects, forms and shapes even when they are viewed from a different angle or in a different environment (Le Roux, 2016d). Visual form constancy helps one to understand that letters, words and numbers remain the same whether in a book, magazine, on a big sign or in a different text or font. For example, irrespective of the different ways in which the letter A may be presented, it will always remain the letter A whether it is in a word like CAT, or in a bigger
text like **C**A**T**, or in a different font like *C**A**T*, or in italics like **C**A*T* (Your Therapy Source, 2013).

Children who struggle with visual form constancy may grapple to categorise and sort objects, organize materials, label items and predict characteristics of an object. Learners who struggle with visual form constancy may frequently reverse letters like **b/d**, **p/q** or **m/w**, transpose numbers like **32/23**, confuse signs like **+/x** and **–/÷**, and confuse similar words like **where** and **were**, or **which** and **wish**, or **pair**, **pear** and **pare** (Dednam, 2005a; 2005b; Gunning, 2006; Your Therapy Source, 2013). In addition, they may not recognise pictures with different directions or size (Ho et al., 2012).

### 3.2.3 Visual Memory

According to Gardner (1996) visual memory is the ability to remember for immediate recall all the characteristics of a given form, and be able to find this among an array of similar forms. Todd (1999, p. 211) defines visual memory as “the ability to retain and recall visual experiences.” Kranowitz (2005) describes visual memory as recognising, associating, storing, and retrieving visual details that one has seen previously. Le Roux (2016e) refers to visual memory as the ability to recall or remember the visual details of what you have seen. Visual memory is the skill that a student requires to remember or recall items, numbers, objects, faces, animals, letters, figures, and/or words which have been previously seen (Tools to Grow, 2016b).

Dednam (2005a) explains that visual memory is the ability to remember visual stimuli. Paying attention is important for this visual perceptual aspect as visual stimuli constantly have to be analysed and memorised. If learners do not pay attention to visual stimuli, they will not be able to remember it at a later stage. Pickering (2001) states that young children appear to
encode pictures of objects in visual form focusing on visual features such as shape, orientation and detailed appearance.

Visual memory is one of the first visual perceptual skills to develop (Johns, n.d.-b) and performance on visual memory tasks have been found to increase until around the age of 11 (Gathercole, Pickering, Ambridge, & Wearing, 2004). The recalled image of a sunset, the remembrance of a flower’s appearance or the memory of a font type, are all instances of visual memory. It is distinct from the auditory memory which requires one to remember what one has heard (Dednam, 2005a).

Bergh and Theron (2003, p. 134) write that one’s memory “is not fixed but rather in a constant state of flux as new connections are made and pathways opened or closed.” In the late 1960s, Atkinson and Shiffrin developed the ‘modal model’ which theorised that the memory consists of three distinct memory types (modes), namely, the sensory memory, the working memory (short-term memory), and the long-term memory. Each mode has a separate function with its own characteristics and limitations, but work in concert to process information (Kirschner, Sweller, & Clark, 2006). The Atkinson and Shiffrin ‘modal model’ of memory, which links these functions, is depicted in Figure 2.2.

![Figure 2.2: Pictorial representation of Atkinson and Shiffrin “modal model”](Ward, 2010, p. 183).
The sensory mode of memory deals with incoming stimuli from the human sense organs. It holds information for a very short time, from a fraction of a second to a few seconds (Fetsco & McClure, 2005). Sensory memories disappear very quickly (Miller, 2011). Cooper (1998) elucidates this by means of the following explanation for the picture below. If one were to shut one’s eyes whilst looking at Figure 2.3, you will still notice an image of the picture remaining for a split second somewhere in the mind. This demonstrates the working of the sensory memory that is responsible for visual perception.

Working memory, also known as short-term memory, can be equated with consciousness. It enables humans to think, to reason and to solve problems (Cooper, 1998). This mode stores small amounts of information for a very short duration (de Jong, 2010). Working memory is limited. It can hold no more than five to nine elements of information and actively process no more than two to four elements simultaneously. It is only able to deal with information 20-30 seconds after which all information is lost unless it is refreshed by rehearsal (van Merriënboer & Sweller, 2010). Sweller et al. (1998) found that this mode of memory is
responsible for the processing of information by identifying, comprehending, organising, classifying, combining, comparing, or contrasting. Cowan (2008) adds that working memory is also used to solve an arithmetic problem without a pen and paper.

According to Friso-van den Bos, van der Ven, Kroesbergen, and van Luit (2013), Baddeley and Hitch (1974) proposed a three-component model of working memory, each with its own limited capacity. These include:

(i) the phonological loop which maintains, manipulates and processes verbal information. Spoken words enter the phonological store directly whereas written words are first converted from a visual code into an articulatory code and then transferred to the phonological loop,

(ii) the visuo-spatial sketchpad which maintains, manipulates and processes visual and spatial information. It deals with characteristics of objects like shape and colour and is responsible for picture processing, and

(iii) the central executive which monitors and coordinates the phonological loop and the visuo-spatial sketchpad and then links them to long-term memory.

Schüler, Scheiter, and van Genuchten (2011)

Long-term memory has the ability to store unlimited amounts of information permanently (Cowan, 2008). The information stored here does not only consist of small, isolated facts but also includes large, complex interactions and procedures (Sweller et al., 1998). Examples of these include; our names, date of birth, how to read, how to write, and anything else that we ‘know’ (Cooper, 1998). Miller (2011) maintains that the information in this mode cannot be used to perform a task unless it is activated. It must first be retrieved and reloaded into the working memory in order to carry out a specific task. The working memory
has no limitations when dealing with information that has been retrieved from the long-term memory.

Visual memory is important to carry out everyday activities such as, remembering the objects needed to brush one’s teeth, remembering directions, recalling a phone number or the steps while cooking a favourite meal (Your Therapy Source, 2013). Visual memory is also the most important visual perceptual aspect required for fluency and speed in reading, spelling, comprehending, writing and mathematics (Clutten, 2009; Your Therapy Source, 2013). Learners who experience challenges with visual memory may have difficulty identifying and remembering letters, sight words, numbers, symbols and signs (Dednam, 2005a; Le Roux, 2016e). They are unable to spell correctly due to their inability to remember the sequence of letters in words (Clutten 2009). They struggle with comprehension and often subvocalize as they read because they rely on auditory input to help them compensate (Eyes Can Learn, n.d.-a). Copying from the blackboard or a book is tedious as they cannot retain the information long enough to transfer it from the board or book and have to keep checking (Le Roux, 2016e).

Heathcote (1994) states that the ability to perform mathematical operations is dependent on visual working memory and argues that the visual memory operates as a mental blackboard on which these mathematical operations take place. Learners who experience challenges with visual memory are unable to identify and remember the direction of numbers and complete simple mathematical computations (Richmond, 2010). They find it challenging to remember the steps they have to use to solve a mathematical problem and constantly check the examples in order to follow every step (Dednam, 2005b).

3.2.4 Visual Sequential Memory

Edwards (1987) defines visual sequential memory as the ability to remember things in the correct sequence in which they were perceived or presented. Gardner (1996) refers to visual
sequential memory as the ability to remember and recall a series of forms in the correct sequence in which it was visually presented. Collmer (2016) describes visual sequential memory as the ability to remember a series of numbers, letters, forms, objects or pictures that have been presented visually and to recall that sequence accurately. Visual sequential memory is the ability to remember and recall a sequence of objects and/or events in the correct order (Your Therapy Source, 2013). Everyday activities of daily living require visual sequential memory. For example, brushing teeth, getting dressed, making a sandwich, cooking, relating an incident, describing an event, or remembering and dialling phone numbers (Johns, n.d.-c; Your Therapy Source, 2013).

Visual sequential memory is crucial to most academic tasks such as reading, spelling and writing (Clutten, 2009; Your Therapy Source, 2013). Dednam (2005a) and Le Roux (2016f) contend that visual sequential memory assists a learner to identify the letters in words in the correct sequence and to remember the sequence of letters in order to spell correctly. Words consist of letters in a specific sequence. Learners have to recognise the letters in sequence, and also remember what word is represented by that sequence of letters. By simply changing the sequence of the letters in name, it can become mean or amen. Richmond (2010) adds that visual sequencing of letters influence the way a learner reads and writes words and sentences as the order of the letters is specific to the end result of the meaning represented by the letters in the words. For example, words like saw/was, left/felt or their/there, and words in sentences such as he comes here/here he comes.

Le Roux (2016f) explains the importance of visual sequential memory to mathematics. When learners are required to perform multiple digit addition and subtraction operations, visual sequential memory helps them to copy the numbers in the correct order. It also influences the way they read, write and calculate numbers greater than nine. For example, 59-9=50 or 95-
Learners who have difficulty with visual sequential memory are often unable; to count in the correct sequence, to remember the alphabet, days of the week or months of the year, to copy from the blackboard or a book, to recognise and remember patterns, or to assemble a picture story in the correct order (Clutten, 2009; Collmer, 2016; Johns, n.d.-c). They repeatedly add, rearrange or omit letters and/or numbers and struggle to remember how to form the letters or numbers without having something concrete to look at (Clutten, 2009).

3.2.5 Visual Spatial-Relationships

Williams (1983) defines visual spatial-relationship as the ability to be aware of, recognise and identify the position and orientation of objects in two dimensional and three dimensional spaces. In the Developmental Test of Visual Perception-2 (DTVP-2), Hammill, et al. (1993, p. 2) describe visual spatial-relationship as “the analysis of forms and patterns in relation to one’s body and space.” Gardner (1996) refers to visual spatial-relationship as the ability to determine a single form that is going in a different direction to other forms. Dednam (2005a) writes that recognising visual spatial-relationship requires the ability to determine the direction of objects in space as well as in their relation to each other. Visual spatial-relationship is the ability to visually perceive two or more objects position in relation to each other and to yourself (Tools to Grow, 2016c; Your Therapy Source, 2013). It has also been defined as the ability to determine that one form or part of a form is turned in a different direction than the others (Therapy Fun Zone, 2016).

Woolf (2013) maintains that visual spatial-relationship grows out of the next visual aspect, position-in-space. Visual spatial-relationship provides us with information about our environment (Visual Learning for Life, 2016b). It encompasses directions, reversals and sequencing (Annandale, 2011; Tools to Grow, 2016c). It includes concepts such as
above/below, before/after, in front of/behind, inside/outside, left/right, beside/behind, on/off, high/low, near/far (Annandale, 2011; Therapy Fun Zone, 2016; Visual Learning for Life, 2016b; Woolf, 2013).

According to Levine (1991) children’s visual spatial concepts develop in the sequence of the vertical dimension first, then the horizontal dimension and lastly the oblique and diagonal dimensions. Children should have acquired and mastered each of these dimensions by the age of eight (Clutten, 2009).

Two important considerations in visual spatial-relationship are laterality and directionality (Eyes Can Learn, n.d.-b). Laterality is the internal self-awareness of the left and right sides of one’s body. Learners need to develop an awareness of the left and right sides of their bodies which is used as a frame of reference. Directionality, which is the ability to see right and left on other objects, builds on laterality, and enables learners to detect how words appear from left to right on a page or recognise the difference between a b/d (Cheatum & Hammond, 2000; Eyes Can Learn, n.d.-b; Kranowitz, 2005; Tools to Grow, 2016c).

Recognising visual spatial-relationships plays an important part in everyday activities and enables one to ask detailed questions, express our ideas, understand directions, and interpret instructions such as ‘stand in the front’ or ‘put the pen inside the box’ (Your Therapy Source, 2013). Visual spatial-relationships are especially important in reading, spelling, writing and mathematics. Seeing such relationships enables learners to form the correct letters, to discriminate between similar letters like b/d, or p/q, to write on a straight line, to read in the correct direction (left to right), and to find the new reading line (Annandale, 2011; Clutten, 2009; Dednam, 2005a). It assists learners in mathematics when they are required to write numbers next to or under one another (Annandale, 2011). It helps learners to complete basic processes, like one-to-one correspondence (seeing that 4 eggs need 4 egg-cups), seriation
(placing objects in order of size and number), and classification (placing objects in groups of similar properties) (Donald, et al., 2010).

Learners who struggle with visual spatial-relationships cannot remember left and right and are often unable to read charts, maps and diagrams (Therapy Fun Zone, 2016). They may also struggle with reversal and rotation of similar looking letters like b/d or p/q, similar looking words like broad/board or drop/prod, and similar looking numbers like 6/9 (Dednam, 2005a) and their spacing between letters and numbers when they write is often inconsistent and incorrect (Clutten, 2009).

The direction of objects, the relationship between objects, and their differences and similarities are important mathematical concepts which learners who experience challenges with visual spatial-relationship are unable to grasp. They may experience problems with place value and confuse tens and units. They find it hard to understand that the value of the 5 on the left of the number 55 is 50 units and the one on the right is only 5 (Dednam, 2005b). When required to perform multiple digit addition and subtraction operations, they compute from left to right, \(48+16=514\) (4+1=5, 6+8=14 which such children write as 514) instead of from right to left \(48+16=64\) (Dednam, 2005a; Therapy Fun Zone, 2016). Learners may also become confused when working on a number line. They may have difficulty with decimals, negative numbers and sequencing involved in solving problems (Dednam, 2005b; Visual Learning for Life, 2016b; Your Therapy Source, 2013).

3.2.6 Position-in-Space

In the Developmental Test of Visual Perception-2 (DTVP-2), Hammill et al. (1993, p. 26) define position-in-space as the ability to “match two figures according to their common features.” They add that position-in-space involves the discrimination of reversals and rotations of figures, forms and objects. Kranowitz (1998) defines position-in-space as the awareness of
the spatial orientation of letters, words, numbers, drawings on a page, or of an object in the environment. Position-in-space is also described as the ability to perceive an object’s position-in-space relative to oneself and the direction in which it is turned (e.g. up, down, in front, behind, between, left, right) (Tools to Grow, 2016c).

Learners who reverse letters struggle with position-in-space and are unable to determine the difference in spatial orientation of letters like b and d, or p and q. Their confusion relates to what position the parts of the letter occupy in relation to one another or the position the letter occupies in the overall space of the paper. Confusion of the letters b and d is related to whether the circle lies to the left or to the right of the straight line. Confusion of the letters p and q is related to whether the straight line lies above or below the blue line on the paper (Visual Learning for Life, 2016a).

3.2.7 Visual Closure

Gardner (1996) defines visual closure as the ability to determine from among incomplete forms, the one that is the same as the completed form. Visual closure is described as the ability to recognise the whole when only a part is seen (Hammill et al., 1993; Kirk et al., 2000; Schneck, 2005). Visual closure is identified as the ability to correctly perceive and recognise an object, form, shape or word, even when it is partly hidden (Lambert, 2010; Le Roux, 2016a).

According to Lambert (2010) visual closure involves visualising and mentally filling in the visual information that is missing. Visual closure assists one to quickly make sense of what one sees and mentally determine what it is before we see the entire object, which means that it is not necessary to see every little detail in order to recognise something (Le Roux, 2016a; Your Therapy Source, 2013). Visual closure is essential for everyday activities of daily living. For example, finding lost objects that are partially hidden, like recognising a sock sticking out
under the bed that has been missing for a few days, or figuring out what a road sign says even when the writing is partly hidden by graffiti (Le Roux, 2016a; Your Therapy Source, 2013). Visual closure can also help to recognise inferences, predict outcomes or make an accurate judgement from partial information (Clutten, 2009).

Visual closure is required for fluency and speed in reading, spelling and comprehending (Clutten, 2009; Your Therapy Source, 2013). Dednam (2005a) maintains that visual closure enhances the reading speed of learners as they can anticipate a word even though the eyes do not orient to every letter of the word. For example, a learner is able to identify the word *aeroplane*, as soon as he/she reads the first two syllables *ae-ro* and sees the *p* or *pl* of *plane*.

Le Roux (2016a) reports that together with visual memory skills, learners need visual closure to help them remember letters and words, especially sight words like *and, the* or *is*. Sight words are individual words that readers have learned to recognize without having to analyse them (Marzouk, 2008). Impairments to visual closure may interfere with a learner’s ability to perceive the entire presentation of what is to be viewed and/or read (Tools to Grow, 2016a). They may find it difficult; to make sense of words on a smudged page, to identify mistakes in written material, to complete partially drawn pictures or dot-to-dot worksheets, to perform mathematical tasks like geometry. They are also unable to quickly recognize words by their shape or general arrangement of letters, to supply a missing letter from a word or a missing word from a sentence, and may leave out parts of words (Le Roux, 2016a; Ross, 2016).

3.2.8 **Visual Figure-Ground**

According to Gardner (1996) visual figure-ground is the ability to perceive a form visually, and to find this form amongst a conglomerated ground of matter. Lerner (2000) defines visual figure-ground as the ability to distinguish an object or form from its surrounding background. Le Roux (2016c) refers to visual figure-ground as the ability to focus on one
specific piece of information in a busy background. Hammill et al. (1993) and Kirk et al. (2000) describe visual figure-ground as the ability to see specified figures even when they are hidden in confusing, complex backgrounds.

Visual figure-ground is the ability to filter visual information that is not important so that one can focus on the relevant visual information, thereby allowing one to find the detailed visual information even when it is part of a busy, complex background (Your Therapy Source, 2013). It allows one to pick up on details or locate forms, shapes, symbols or objects that are hidden while ignoring extraneous visual information (Ho et al., 2012; Richmond, 2010; Your Therapy Source, 2013).

Children who struggle with visual figure-ground will find it difficult to carry out everyday activities. For example, finding a specific toy among toys in a toy-box, or finding a personal items in a cluttered cupboard, or finding a sign, or finding a face in a crowd, or finding an item that has fallen onto a similar coloured background, like a green button that has fallen on the grass (Kranowitz, 2005; Le Roux, 2016c). Other examples would be; looking at a map and separating the writing from the drawings in order to find the name of a city, or looking in a telephone directory and reading each line in order to locate the name and number of a specific person, or reading a flyer on a busy bulletin board, or following a recipe (Johns, n.d.-a; Richmond, 2010; Your Therapy Source, 2013).

Visual figure-ground is necessary for reading, mathematical operations and the ability to maintain attention (Richmond, 2010; Your Therapy Source, 2013). Dednam, (2005a) writes that visual figure-ground assists learners to read at a specific place in a book without losing that specific place. She further explains that although learners are aware of the lines, letters and words surrounding what they are reading, they do not pay attention to them. Learners who experience challenges with visual figure-ground are unable to focus on the item in question
and extract it from the visual background (Clutten, 2009). They are easily confused and get lost with too much print on a page, affecting their concentration and attention. They are unable to isolate letters and numbers in order to identify them and use them meaningfully when reading or performing mathematical calculations (Richmond, 2010). They may struggle to find information on a blackboard, to copy from a blackboard, to find a place on a page, to find a word on a page, to find details in a picture, to draw lines between boundaries, to read graphs, charts or diagrams, or to pick out numbers in a word problem (Johns, n.d.-a; Kranowitz, 2005; Le Roux, 2016c; Richmond, 2010; Your Therapy Source, 2013). They may also struggle with map work, have poor dictionary skills, and are unable to maintain their attention for long periods (Johns, n.d.-a; Le Roux, 2016c; Your Therapy Source, 2013).

3.2.9 Visual Analysis and Synthesis

Visual analysis is defined as the ability to break up (analyse) objects, forms and words. Visual synthesis is the opposite and is defined as the ability to put together (assemble) parts such as letters or syllables to form words (Clutten, 2009). Annandale (2011) refers to visual analysis and synthesis as the ability to combine parts of a unit to form a whole, or to divide the whole into separate parts. Lambert (2010) defines visual analysis and synthesis as the ability to see that certain parts make a whole. This is the understanding of the relationship between parts of a figure, word or sentence and the whole figure, word or sentence.

Visual analysis and synthesis is especially important in reading, spelling, writing and mathematics (Annandale, 2011; Clutten, 2009). Learners who struggle to analyse and synthesise may have difficulty putting letters together (visual synthesis) to form a word, and breaking the word up into its constituent letters (visual analysis). For example, learners may grapple to combine the letters c,a,t to form the word cat (visual synthesis), and again to break the word down into separate letters (visual analysis) (Annandale, 2011).
Dednam (2005a) explains that visual analysis and synthesis enables learners to analyse words into their letter sounds and to synthesise the sounds into understandable words. Learners who struggle to analyse and synthesise may experience problems understanding the rules of word syllabification which assist them to analyse words into their syllables or to synthesise syllables into a word. For example, when asked to analyse the word develop, learners will write deve-l-op instead of de-velop. Visual information processing speed has been closely linked with the ability to analyse visual information. The visual processing speed of learners who grapple to analyse is strained and affects their reading and writing (Scheiman & Gallaway, 2006).

3.3 Measures of visual perception

Recognising the importance of visual perception, studies reveal that theorists and researchers began developing visual perceptual tests as early as the 1930s. Since then, more refined, standardised tests were developed (Brown et al., 2003). Some of these included the Visual Motor Gestalt Test (Bender, 1938), Frostig Developmental Test of Visual Perception (DTVP) (Frostig, 1963), Motor-Free Visual Perception Test (MVPT) (Colarusso & Hammill, 1972), Test of Visual-Perceptual Skills (Gardner, 1982), Developmental Test of Visual Motor Integration (Beery & Buktenica, 1982; Beery, 1989), and the Test of Visual-Motor Skills (Gardner, 1986).

Brown et al. (2003) report that during the 1990s four of the above-mentioned tests were revised; the Developmental Test of Visual Perception-2 (DTVP-2) (Hammill et al., 1993), the Motor-Free Test of Visual Perception-Revised (MVPT-R) (Colarusso & Hammill, 1996), the Test of Visual Perceptual Skills-Revised (Non-Motor TVPS-R) (Gardner, 1996), and the Developmental Test of Visual Motor Integration (Beery, 1997).
The most frequently administered tests like the American standardised Bender-Gestalt Visual Motor Test (Bender-Gestalt) and the Beery-Buktenica Developmental Test of Visual Motor Integration (Beery-VMI) have gained recognition as effective tests which purport to measure the construct of visual perception. However, these tests are more apt to measure modalities of visual-motor integration and not distinct visual perceptual aspects. This is affirmed by Cummings, Hoida, Machek, and Nelson (2003) and Sattler (2002) who claim that the focus of these tests are on visual-motor perception and integration abilities.

Despite the fact that the above-mentioned tests are widely used in South Africa as part of an assessment battery (Foxcroft, Paterson, Le Roux, & Herbst, 2004), practitioners within South Africa have not been provided with appropriate standardised norms for the South African population for either the Beery-VMI or the Bender-Gestalt test. Foxcroft and Roodt (2001) and the Health Professions Council of South Africa (2007) maintain that it is crucial to adapt appropriate assessment instruments in order to eliminate any bias from these identified psychometric tools within multicultural South Africa.

South African educational psychologist, Sylvia Catherine Clutten, recognised that a standardised visual perception test, specifically designed to address the South African educational context, did not exist. Understanding the importance of visual perception, she developed the Visual Perceptual Aspects Test (VPAT) which adequately measures distinct visual perceptual aspects of South African Foundation Phase learners ranging between five and ten years of age. The test is discussed in detail below.

3.3.1 Visual Perceptual Aspects Test

The Visual Perceptual Aspects Test (VPAT) consists of nine individual subtests, namely, visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S),
visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S). Each subtest comprises of 16 items which are made up of shapes, forms or designs arranged from easy to more complex forms. Each form is housed in a stand-alone box with a distinctive border. The learner is instructed to meticulously observe the form. Thereafter, depending on the visual perceptual aspect being assessed or evaluated, the learner is instructed to choose an answer from a multiple-choice selection of forms or designs. Every successful response is awarded one mark and the marks are added to provide a total raw score for that specific subtest. The learner is allocated 9 seconds within which to select an answer from among a multiple-choice selection of possible responses for seven of the subtests. The allocated time for the remaining two subtests, namely, Visual Memory (VM) and Visual Sequential Memory (VSM) ranges between five and fourteen seconds. The ceiling for each of the nine subtests is three consecutive unsuccessful attempts.

The forms are presented in a ‘top-to-bottom’ or a ‘left-to-right’ presentation of choices. In each subtest the first four items are intended for Grade R learners (i.e. top-to-bottom) and the remaining 12 items intended for Grades 1-3 (i.e. left-to-right). The reason for combining these two formats in each subtest is that learners visually attend to forms or objects in a “top-to-bottom” approach in the early stages of visual observation. Later, in learning to read, learners are required to read from left-to-right (Clutten, 2009).

For assessment and evaluation purposes, the nine subtests have been divided into four sections, namely, (i) visual discriminatory aspects, (ii) visual memory aspects, (iii) visual spatial processing aspects, and, (iv) visual perceptual analytical aspects. Each section evaluates identified aspects of visual perception, from its simplest level (visual discrimination) to more advanced visual information processing and analytical abilities. Each section is discussed in detail below.
Section 1: Evaluation of visual discriminatory aspects

Forms, shapes and designs have distinctive features which may include, size, shape, colour and/or directional orientation of that form, shape or design. The learner’s awareness of these distinctive features in any given form reflects an ability regarding the discriminatory aspects of visual perception (Clutten, 2009).

Two subtests in Section 1, namely, Visual Discrimination (VD) and Visual Form Constancy (VFC), assess and evaluate the learner’s visual discriminatory aspects of visual perception. Figures 2.4 and 2.5 below illustrate one of the items from each of the subtests.

- Subtest 1, Visual Discrimination (VD): assesses and evaluates the learner’s ability to merely be conscious of the similarities or differences regarding distinctive features of forms, and

- Subtest 2, Visual Form Constancy (VFC): assesses and evaluates the learner’s ability to discern and/or identify a form irrespective of its size, colour or positional orientation.

Figure 2.4: Example of an item from the Visual Discrimination (VD) subtest of the Visual Perceptual Aspects Test (Clutten, 2009).
These two subtests are identical in their construction, administration and scoring. Each subtest consists of 16 discrete plates that are arranged from easy to more complex forms. The learner is instructed to meticulously observe the form that is housed in a stand-alone box with a distinctive border. The learner is then instructed to find the exact same form or design in a multiple-choice selection of forms or designs. Items available for the learner to choose from steadily increases from two to seven items (i.e. Grade R – two items, Grade 1 – three items, Grade 2 – five items, and Grade 3 – seven items). The items become more complex in nature (i.e. more details to observe and discriminate) as well as more refined in size. The learner is allocated 9 seconds within which to select an answer from among a multiple-choice selection of possible responses. Every successful response is awarded one mark and the marks are added to provide a total raw score.

Section 2: Evaluation of visual memory aspects

Aspects which facilitate visual memory include attention, identification, recognition, visualisation and recall (Clutten, 2009).

Two subtests in Section 2, namely, Visual Memory (VM) and Visual Sequential Memory (VSM), assess and evaluate the learner’s visual memory aspects of visual perception. Figures 2.6 and 2.7 below illustrate one of the items from each of the subtests.
Subtest 3, Visual Memory (VM): assesses and evaluates the learner’s ability to recognise and recall visually presented stimuli. The capacity for short-term spatial memory is also assessed, as the learner is expected to not only recognise and recall the form, but also indicate whether the form has been transposed in any way, and

Subtest 4, Visual Sequential Memory (VSM): assesses and evaluates the learner’s ability to distinguish and recall information, which is sequential in nature.

Figure 2.6: Example of an item from the Visual Memory (VM) subtest of the Visual Perceptual Aspects Test (Clutten, 2009).
The two subtests are identical in their construction, administration and scoring. Each subtest consists of 16 discrete plates that are arranged from easy to more complex forms. The learner is instructed to look at the initial plate containing a single form and to view it within an allocated timeframe. The screen with the initial plate disappears and the next screen displays the items to choose from. Items available for the learner to choose from steadily increases from two to six items for the Visual Memory (VM) subtest (i.e. Grade R – two/three items, Grade 1 – four items, Grade 2 – five items, and Grade 3 – six items), and two to nine items for the Visual Sequential Memory (VSM) subtest (i.e. Grade R – two/three items, Grade 1 – three/four/five items, Grade 2 – five/six/seven items, and Grade 3 – seven/eight/nine items). The items become more complicated and progressively refined in nature (i.e. more details to
observe and recall) as well as more refined in size. The learner selects an answer from among a multiple-choice selection of possible responses. Every successful response is awarded one mark and the marks are added to provide a total raw score.

The allocated time for both subtests depends on the difficulty level of the item displayed and the number of forms in the sequence. For the Visual Memory (VM) subtest, as the level of difficulty and the number of forms increases, the allocated time decreases from eight to five seconds (i.e. Grade R – two/three items: eight seconds, Grade 1 – four items: seven seconds, Grade 2 – five items: six seconds, and Grade 3 – six items: five seconds). For the Visual Sequential Memory (VSM) subtest, as the level of difficulty and the number of forms increases, the allocated time increases from five to fourteen seconds (i.e. Grade R – two/three items: five seconds, Grade 1 – three/four/five items: nine seconds Grade 2 – five/six/seven items: twelve seconds, and Grade 3 – seven/eight/nine items: fourteen seconds).

Section 3: Evaluation of visual spatial processing aspects

The ability to comprehend the orientation of visual information in two-and three-dimensional space is known as visual spatial processing. It is a complex process which involves multiple, distinct, yet interrelated components (i.e. the fundamental ability to discriminate between forms, to scan, to rotate forms mentally, to analyse and to compare forms) (Clutten, 2009).

Two subtests in Section 3, namely, Visual Spatial-Relationship (VSR) and Position-in-Space (P-S), assess and evaluate the learner’s visual spatial processing aspects of visual perception. Figures 2.8 and 2.9 below illustrate one of the items from each of the subtests.
Subtest 5, Visual Spatial-Relationship (VSR): assesses and evaluates the learner’s ability to merely be conscious of a design that has been transposed in some way (inverted, rotated or mirrored), but retains its identity, and

Subtest 6, Position-in-Space (P-S): assesses and evaluates the learner’s ability to be aware of his/her own body in relation to a particular seen form in space.

Figure 2.8: Example of an item from the Visual Spatial-Relationship (VSR) subtest of the Visual Perceptual Aspects Test (Clutten, 2009).

Figure 2.9: Example of an item from the Position-in-Space (P-S) subtest of the Visual Perceptual Aspects Test (Clutten, 2009).

The construction, items development (16 discrete plates per subtest), administration and scoring are identical to that of the subtests described in Section 1.

**Section 4: Evaluation of visual perceptual analytical aspects**

These remaining three subtests require a higher level of processing visual information.

Three subtests in Section 4, namely, Visual Closure (VC), Visual Figure-Ground (VF-G) and Visual Analysis and Synthesis (VA/S) assess and evaluate the learner’s visual
perceptual analytical aspects of visual perception. Figures 2.10, 2.11 and 2.12 below illustrate one of the items from each of the subtests.

- **Subtest 7, Visual Closure (VC):** assesses and evaluates the learner’s ability to recognise clues in the visual array and determine the final percept, without all the details being present or visible, and

- **Subtest 8, Visual Figure-Ground (VF-G):** assesses and evaluates the learner’s ability to attend to and identify a specific form while remaining conscious of the relationship between the form and the information in the background. The learner is requested to locate and match a specific stimulus (form) embedded within a complex or distracting background, and

- **Subtest 9, Visual Analysis and Synthesis (VA/S):** assesses and evaluates the learner’s ability to analyse (break up) visual information, or synthesise (re-assemble) visual information. The items in this subset alternate between VA and VS.

![Figure 2.10: Example of an item from the Visual Closure (VC) subtest of the Visual Perceptual Aspects Test (Clutten, 2009).](image)
Figure 2.11: *Example of an item from the Visual Figure-Ground (VF-G) subtest of the Visual Perceptual Aspects Test (Clutten, 2009).*

Figure 2.12: *Example of an item from the Visual Analysis and Synthesis (VA/S) subtest of the Visual Perceptual Aspects Test (Clutten, 2009).*

The construction, items development (16 discrete plates per subtest), administration and scoring are identical to that of the subtests described in Section 1.

4. **EXPLORATORY TALK**

The use of language is essentially to communicate with each other and is developed during the formative years. These include the many years spent at school engaging with teachers and peers in classroom talk (Mercer & Hodgkinson, 2008). For many years, classroom talk has been the subject of school-based educational research but, in more recent years, researchers have become increasingly aware and are trying to understand how social experiences shape children’s thinking (Webb et al., 2016).

Socio-cultural theorist, Vygotsky (1978) contended that a learner’s actual achievement is a combination of their own ability and the effectiveness of the communication between the teacher and learner. Mercer (2000) reconceptualised Vygotsky’s theory and proposed that in
order to learn, learners must create a shared communicative space of common knowledge in which they negotiate their way through an activity. Mercer (2000) termed this the Intermental Development Zone (IDZ) and claimed that if the IDZ was maintained, and learners operated just above their ability levels, effective learning through collaborative dialogue could take place.

Mercer et al. (1999) found that learners’ understanding and learning could be improved if they were introduced to a form of talk where they engaged critically and constructively with each other’s ideas. Alexander (2008) elaborated on Mercer and Sams (2006) further findings on this matter and postulated that it is possible to exploit the power of talk, both between teacher and learner and between learners, to shape learners’ thinking and to secure their engagement, learning and understanding. This form of talk “where knowledge is made publicly accountable and reasoning is visible in the talk” (Monaghan, 2006, p. 13) is known as ‘exploratory talk’ (Barnes & Todd, 1977). Habermas (1990) termed exploratory talk ‘communicative rationality.’

Exploratory talk was first identified by the pioneering British educational researcher Douglas Barnes (Barnes & Todd, 1995). Mercer defines exploratory talk as:

That in which partners engage critically but constructively with each other’s ideas. Relevant information is offered for joint consideration. Proposals may be challenged and counter-challenged, but if so reasons are given and alternatives are offered. Agreement is sought as a basis for joint progress. Knowledge is made publicly accountable and reasoning is visible in the talk. (Mercer, 2000, p. 98)

Exploratory talk is therefore seen as a social mode of thinking (Mercer, 1996) orientated towards a shared inquiry, enabling learners to explore different viewpoints and ideas within a group. Learners try to solve problems together until a common understanding is reached (Rajala, Hilppo, & Lipponen, 2012). Some of the words commonly associated with exploratory

Exploratory talk has shown to contribute to the development of learners language (Mercer & Dawes, 2008), their subject learning and reasoning skills (Mercer & Dawes, 2008; Mercer, Dawes, Wegerif, & Sams, 2004; Mercer et al., 1999; Mercer & Sams, 2006; Webb et al., 2016; Wegerif, Mercer, & Dawes, 1999), as well as their ability to solve problems in groups and individually (Rojas-Drummond & Zapata, 2004; Wegerif et al., 1999; Wegerif, Perez, Rojas-Drummond, Mercer, & Velez, 2005).

It has been perceived as an important educational tool for guiding the development of understanding and for jointly constructing knowledge (Mercer & Hodgkinson, 2008). Wells and Ball (2008) propose that exploratory talk is important to the development of understanding for at least three reasons: (i) it affords learners a sense of ownership over their own learning, (ii) it affords the feeling of being understood, and (iii) it can be internalised to mediate learners’ understanding and problem-solving. Barnes (2008) explains that learners’ construction of knowledge is not arbitrary but rather based on activities, experiences and talks shared with other learners or members of community. He further clarifies that when learners construct knowledge they are merely manipulating what is already available or known to them. Exploratory talk therefore does not provide new information (Barnes, 2008).

Given the right context, in terms of task and pedagogic approach, all learners have the potential to actively engage in exploratory talk and benefit therefrom (Barnes, 1976). This was confirmed in a study conducted by Light et al. (1994) who concluded that all learners can benefit from discussions provided they work in same ability (symmetrical) groups since such groups will ensure an even status of power and provide more opportunities for learners to scaffold each other’s learning.
According to Setati, Adler, Reed, and Bapoo (2002) it is important for learners to explore ideas and concepts in a comfortable environment. In exploratory talk, a learner ‘thinks aloud’, taking the risk that other learners can hear and comment on partly-formed ideas. This is rather a brave thing to do and will only happen if there is a degree of trust within the group (Mercer & Dawes, 2008). Pierce and Gilles (2008, p. 51) suggest that “when learners feel comfortable with one another they can begin to explore new boundaries to their learning and to challenge one another’s thinking. They can feel safe sharing ‘half-baked’ ideas, revising their own thinking, and questioning the ideas of others.” The ‘thinking aloud’ process triggers ideas as their minds tap into previous constructs to come up with new, creative and well-reasoned ideas (Mercer & Dawes, 2008).

Teachers can facilitate the development of effective exploratory talk by laying down explicit ground rules for talk (Monaghan, 2006). Ground rules for talk are important as they reflect the need for social order of a certain kind to be maintained in the classroom. It is the teacher’s duty to alert and explain these specific rules to their learners, and get them to buy into these rules before they can expect them to engage in exploratory talk (Webb, 2008).

According to Rojas-Drummond and Mercer (2003) ground rules help learners to co-reason, share knowledge, evaluate evidence and consider options and ideas in an equitable and reasonable way. Dawes and Sams (2004) contend that the ground rules assist learners to pay attention to the way they speak and listen, thereby giving everyone a chance to contribute to the joint activity. In doing so they think and learn together, achieving more by working in a group than they would on their own.

Some of the ground rules for exploratory talk mentioned by Dawes and Sams (2004) are that each person should be invited to talk, everyone should listen carefully, reasons are asked for and given, agreements and disagreements are accepted as part of the discussion,
members of a group respect each other’s opinions and ideas, all information is shared, and the group seeks to reach agreement before taking a decision. Mercer and Dawes (2008) add that it is acceptable for anyone to ask a question or interrupt the speaker.

Studies suggest that exploratory talk is essential to the teaching and learning of science (Dawes, 2004) and mathematics (Barwell, 2005; Mercer & Sams, 2006). Scott (2008) claims that teachers, through exploratory talk, can help learners move from an everyday understanding of specific phenomenon to a scientific understanding of that same phenomenon. Dawes writes:

Children learning science in schools simultaneously experience learning in many areas. They can learn how to enquire, reason, to consider evidence and information, to make deductions, to share and negotiate their ideas with others, and to make decisions. Teachers can further help children to do this by raising their awareness of speaking and listening as a tool for thinking together. (Dawes, 2004, p. 677-678).

Exploratory talk also plays an important role in improving mathematical understanding. Developing mathematical understanding is a socially constructed activity (Rabel & Wooldridge, 2013) and it is through the informal use of mathematical language that more insightful mathematical thinking can begin to develop (Leung, 2005). Barwell (2005, p. 146) states “Language is about more than words; mathematics is about more than numbers.”

The National Council of Teachers of Mathematics (2000, p. 60) states, “Communication is an essential part of mathematics and mathematics education.” Clements claim that “educators enhance children’s mathematics learning when they ask questions that provoke clarifications, extensions, and development of new understandings.” These statements attest to the importance of providing learners with opportunities to communicate their mathematical thinking and ideas to their peers and teachers (Cooke & Buchholz, 2005).
A number of studies were carried out in South Africa (Sepeng, 2010; Villanueva, 2010; Webb, 2010; Webb & Treagust, 2006) where teachers effectively engaged their learners in exploratory talk during science and mathematics inquiry activities over a period of 6 months and more. Statistically significant gains were recorded in the learners’ reasoning abilities (Webb et al., 2016).

Despite the important role exploratory talk plays in the primary classroom, Kutnick and Manson (2000) and Williams (2008) suggest that it is not always a successful learning strategy. This is particularly the case if the nature of the activity does not invite children to engage in exploratory talk (Rabel & Wooldridge, 2013). Mercer and Sams (2006, p. 510) found that the talk which takes place in primary schools when learners work together can often be “uncooperative, off-task, inequitable and ultimately unproductive.” Another impeding factor is that teachers have often received little to no training on how to encourage group discussion (Blatchford, Goldstein, & Mortimore, 1998). Learners therefore cannot be expected to engage in exploratory talk without adequate guidance (Rabel & Wooldridge, 2013). Mercer (1995) contends that learners should be taught how to talk effectively together and assisted to develop dialogic strategies to think collectively.

Another concern regarding exploratory talk is that it may not foster the learning of every member of a group. Research suggests that asymmetries of talk, particularly differences in the amount of talk, predict differences in learning gains (Bianchini, 1999; Cohen, 1994). Equal opportunities to engage in exploratory talk may be provided to all learners, yet some may choose to participate while others may decide not to get involved (Rajala et al., 2012).

The Raven’s Coloured Progressive Matrices (RCPM) test has commonly been used to test non-verbal reasoning. Wegerif et al. (1999) seminal study was the first to provide the link between exploratory talk and achievements on the Raven’s test. Children’s test scores
improved significantly after being taught to use exploratory talk during group activities aimed at solving the reasoning problems posed in the Raven’s test. The RCPM is discussed in detail below.

4.1 Raven’s Coloured Progressive Matrices

The Raven’s Coloured Progressive Matrices (RCPM) is a widely used, well-established, reliable standardised test which was originally designed to measure ‘deductive reasoning’ in children, i.e. the capacity to deduce, store and reproduce information (Van den Heuvel & Smits, 1994). It is specifically designed for use with young children under 11 years of age (Raven, Raven, & Court, 1998) and is known as one of the best measures of general cognitive abilities including Speaman’s $g$ (Lanfranchi & Carretti, 2012). Researchers have used the test to measure other aspects of cognitive ability such as, fluid intelligence (Woliver & Sacks, 1986; Van den Heuvel & Smits, 1994), abstract reasoning and to estimate IQ (Lanfranchi & Carretti, 2012). As the RCPM involves the matching of a target to a pattern it is also considered to be a visuo-spatial perception test (Gunn & Jarrold, 2004; Van Herwegen, Farran, & Annaz, 2011).

The non-verbal nature of the RCPM has made it attractive to psychologists wishing to compare ability across cultures where language-based tests are inappropriate. Research demonstrates that the test is equally reliable for ethnic groups (Carlson & Jensen, 1981) and seen as a valid measure of nonverbal intelligence for children of culturally and linguistically diverse backgrounds (Valencia, 1984). RCPM has been used extensively across a wide variety of settings in different countries all over the world which include, Lithuanian children (Gintilienė & Butkienė, 2005), Omani children (Kazem et al., 2009), Kenyan children (Costenbader & Ngari, 2001), Inuit children in Arctic Quebec (Wright, Taylor, & Ruggiero,

Van den Heuvel and Smits (1994) claim that because of its widespread use and psychometric values, the RCPM can be seen as an attractive instrument. Kazem et al. (2009) concluded after their study that RCPM has a number of applications. They suggested that the Ministry of Education could use it to diagnose and detect those children with learning disabilities, the Ministry of Health could use it in hospitals to measure the IQ of certain patients in order to make medical decisions, and researchers in psychological and social sciences could use the RCPM in studies which aim to measure the intelligence of children.

The RCPM test comprises 36 items which are divided into three subtests of 12 items each (A, AB and B). To attract and hold the attention of young children, each item is presented as a pattern on a brightly-coloured background. Each item consists of one drawing (matrix) of a pattern from which a portion is missing. Below the matrix, 6 options are presented from which to choose to fill in the missing portion. Figure 2.13 illustrates one of the items from set AB. The complexity of the items increase in each subtest, requiring higher levels of cognitive reasoning in the form of completing a continuing pattern, developing comparisons, reasoning by analogy, and organising spatial perceptions into systematically related wholes (Facon, Magis, Nuchadee, & De Boeck, 2011). There is no set time limit to complete each item.
Figure 2.13: *Example of an item from subtest AB10 of Raven’s Coloured Progressive Matrices* (Raven et al., 1998).

5. **FRAMING THIS STUDY**

The notions of play, particularly construction play with ‘6 Bricks’, visual perception and exploratory talk provide the framework in which this research study is situated. The basic
aim of this study is to investigate the effect that the ‘6 Bricks’ approach has on the development of learners’ visual perception and reasoning abilities. An intervention period of 6 months was implemented during which learners completed various activities using the ‘6 Bricks’. The Visual Perceptual Aspects Test (VPAT) and Raven’s Coloured Progressive Matrices (RCPM) was computerised. The lens through which the results are viewed include the nine aspects of visual perception and reasoning.

6. CHAPTER SUMMARY

This chapter provides an overview of three main issues, namely, play, visual perception and exploratory talk. Issues pertaining to play such as, the definitions, descriptions, explanations, interpretations, characteristics, features, categories, construction play, importance, pedagogical value and the ‘6 Bricks’ approach were explored. Visual perception, the development and measures of visual perception, as well as the nine aspects of visual perception namely, visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S) were described. Notions of exploratory talk, its definitions, explanations, words, ground rules and the impact of exploratory talk on the development of reasoning abilities were explored. These theoretical frameworks are not only useful as explanatory tools, but are drawn together to provide a conceptual framework for the design of the study which is elaborated on in chapter three.
CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

1. INTRODUCTION

This chapter describes and justifies the philosophical underpinnings of this study, the theoretical perspectives behind the methodology, and the methods of data collection and analysis. Pragmatism and mixed method approaches are interrogated before presenting an argument for using a mixed method approach. Thereafter, the selection of schools and teachers are described, the research design and research strategy is discussed, the data generating instruments are specified, and the data collection and analysis techniques are explained. In addition, validity and reliability, as well as ethical considerations, are considered.

2. RESEARCH PARADIGMS

According to Morgan (2007) the term ‘paradigm’ has become a central concept commonly used within the field of social science. Cohen and Manion (1994, p. 38) define a paradigm as “the philosophical intent or motivation for undertaking a study.” Guba and Lincoln (1994, p. 105) view a paradigm as “the basic belief system or worldview that guides the investigator.” Mertens (2010, p. 7) describes a paradigm as “a way of looking at the world. It is composed of certain philosophical assumptions that guide and direct thinking and action.”

Scientific research is conducted with a specific way of looking at the world and researchers are therefore required to consider and understand the epistemological (theory of knowledge), ontological (theory of reality, existence and being) and methodological (research strategy or strategy of inquiry) assumptions of different paradigms before deciding on how they will conduct their research (Cohen, Manion, & Morrison, 2007; Guba & Lincoln, 1994;
An understanding of the paradigm within which one is working defines the intent, motivation and expectations of the research (Mackenzie & Knipe, 2006). Without this understanding there is little basis for subsequent choices regarding literature, methodology, methods, or research design (Morgan, 2007).

The research undertaken in this study does not fall within one paradigm exclusively. Instead, a mixed method approach was adopted wherein the qualitative data supports, expands, explains and effectively deepens the description provided by the quantitative data (Creswell, 2003). The emphasis on either quantitative or qualitative data locates the research in a particular position within the ‘pragmatic’ paradigm (Creswell, 2003).

2.1 Pragmatism

Towards the late 1980s into the early 1990s, pragmatism evolved as a third research philosophy (Howe, 1988). Derived from the work of Pierce, James, Mead, Dewey and more recently, Rorty, Murphy, Patton and Cherryholmes (Creswell, 2009), pragmatism has been referred to as ‘consequences of action,’ ‘problem-centred,’ ‘pluralistic,’ ‘mixed models’ (Mackenzie & Knipe, 2006), ‘mixed methods’ (Creswell & Plano Clark, 2011) and ‘mixed methods research’ (Johnson & Christensen, 2008).

Pragmatists explain that the complexity of our research problems calls for answers beyond simple numbers in a quantitative sense (positivist/post-positivist paradigm) or words in a qualitative sense (interpretivist/constructivist paradigm) and believe that a combination of both forms of data will provide the most complete analysis of problems (Creswell & Plano Clark, 2011), opening the door to multiple methods, as well as different forms of data collection and analysis (Creswell, 2009). The underlying philosophy of the pragmatic paradigm is that it provides the theoretical framework for mixed methods research (Mertens, 2005). Creswell and
Plano Clark (2011, p. 41) state “the focus is on the consequences of research, on the primary importance of the question asked rather than the methods, and on the use of multiple methods of data collection to inform the problems under study. Thus it is pluralistic and oriented toward ‘what works’ and practice.” Pragmatists, therefore, focus on “the ‘what’ and ‘how’ of the research problem” (Creswell, 2003, p. 11).

By placing the research question at the centre of the study, pragmatists then choose the data collection and analysis methods that are most likely to provide insights into the research question (Mackenzie & Knipe, 2006). The pragmatic paradigm allows researchers to decide and draw liberally from both quantitative and qualitative methodologies within the same research study rather than subscribing to only one way (quantitative or qualitative) (Creswell, 2009). It was for the reasons cited above that a pragmatic, mixed-methods approach was used in this study.

3. MIXED METHODS

Philosophically, the mixed method approach, which has emerged over the past two decades (Denscombe, 2008), operates within the pragmatic paradigm (Johnson, Onwuegbuzie, & Turner, 2007; Mertens, 2010). Notably, the mixed method approach has evolved to the point where it is “recognized as the third major research approach or research paradigm, along with qualitative and quantitative research” (Johnson et al., 2007, p. 112).

Creswell and Plano Clark (2007, p. 5) comprehensively define mixed methods research as:

Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative
and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analysing, and mixing both quantitative and qualitative data in a single study or a series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. (Creswell & Plano Clark, 2007, p. 5)

The fundamental principle of mixed methods research is to combine the methods in a way that achieves complementary strengths and non-overlapping weaknesses (Johnson & Onwuegbuzie, 2004) and is believed to be an excellent way to conduct high-quality research (Johnson & Christensen, 2008). Du Plessis and Majam (2010) clarify that a mixed method approach is similar to including a quantitative mini-study and a qualitative mini-study in one overall research study. Denscombe (2008) maintains that a mixed method approach clearly specifies the sequencing and priority that is given to the quantitative and qualitative elements of data collection and analysis. Creswell (2003) explains that a mixed method approach is one that involves both numeric information (e.g. instruments) as well as text information (e.g. interviews) so that the final database both represent quantitative and qualitative information.

In this study the qualitative data generated from observations, teacher record sheets and teacher interviews were weighed against quantitative data from pre- and post-tests to increase the validity and trustworthiness of the research results. The use of quantitative and qualitative methods provided a clearer illustration of the data (Creswell, 2005). The mixed method approach can therefore be seen as an expansive and creative form of research, and not a limiting form of research (Johnson & Onwuegbuzie, 2004).
3.1 Rationale for using a mixed method approach

Two of the major purposes or rationales for using a mixed method approach are triangulation and complementarity. Triangulation seeks convergence, corroboration and correspondence of results from different methods whereas complementarity seeks elaboration, enhancement, illustration and clarification of the results from one method with the results from the other method (du Plessis and Majam, 2010). According to Johnson and Onwuegbuzie (2004), the mixed method approach ensures the minimisation of weaknesses through the triangulation of varied data. Triangulation is deemed useful when providing qualitative explanations to quantitative findings and vice-versa. This study utilised triangulation and complementarity. Qualitative data generated from teacher record sheets, researcher observations and teacher interviews were weighed against quantitative data from pre- and post-tests to increase the validity and trustworthiness of the research results.

3.2 Mixed method design

This study adopted an explanatory sequential design which occurs in two distinct interactive phases (Creswell, 2005) as shown below in Figure 3.1. The design started with the collection and analysis of quantitative data, which had priority when addressing the study’s questions. This first phase was followed by the subsequent collection and analysis of qualitative data. The second, qualitative phase of the study was designed so that it followed from the results of the first, quantitative phase. I used the qualitative results to help to explain (interpret) the initial quantitative results. Priority was unequal and given to the quantitative data with the qualitative data being used to help make sense of the quantitative findings (Creswell, 2005, 2009; Creswell & Plano Clark, 2011; de Vos, Strydom, Fouche, & Delport, 2011).
The explanatory sequential design

![Diagram: The framework for the explanatory sequential mixed methods design depicting the sequence researchers adhere to (Creswell & Plano Clark, 2011, p. 69).]

This study employed an explanatory sequential design as quantitative data in the form of pre- and post-tests were conducted and analysed, after which teacher interviews took place. Qualitative data was collected via teacher record sheets and researcher observations during the intervention, but was only analysed subsequent to the generation and analysis of the quantitative data.

### 3.3 Mixed method procedures

Several aspects influence the design of procedures for a mixed-method study. Three important aspects are timing, weighting and mixing (Creswell, 2009; Creswell & Plano Clark, 2011). The mixed method procedure for this study combined:

- **sequential quantitative first timing**: pre- and post-tests (quantitative data) were administered and analysed before the teacher record sheets, researcher’s observations and teacher interviews (qualitative data) were analysed,

- **quantitative priority**: greater emphasis was placed on the quantitative data which consisted of a large sample (n=443 for the Visual Perceptual Aspects Test (VPAT) and (n=436 for the Raven’s Coloured Progressive Matrices)), and
Chapter Three - Research Design and Methodology

- *embedded mixing*: the observations, teacher record sheets and teacher interviews (qualitative data) provided supportive information about the pre- and post-test results (quantitative data).

4 RESEARCH DESIGN

According to McMillan and Schumacher (2006, p. 117) “the term research design refers to a plan for selecting subjects, research sites, and data collection procedures to answer the research question(s). The design shows which individuals will be studied and when, where, and under which circumstances they will be studied. The goal of a sound research design is to provide results that are judged to be credible.”

4.1 Quasi-experimental designs

The main purpose of an experimental design is to investigate possible cause-and-effect relationships between interventions and measured outcomes (McMillan & Schumacher, 2006). Quasi-experimental designs are carried out in a natural setting with the selection of at least one experimental and at least one comparison group. Such a design includes selection, but not random selection, of groups (Creswell, 2005; Mertens, 2010), which distinguishes it from truly experimental designs. In education, many experimental situations occur in which researchers need to use intact groups and, therefore, use quasi-experimental designs. This usually happens because of the availability of the subjects (Creswell, 2005).

Cohen et al. (2007) and Creswell (2005) mention that quasi-experimental designs come in several forms. One such design is the pre- and post-test design. The researcher assigns intact groups the experimental and control treatments, administers a pre-test to both groups, conducts experimental treatment activities (interventions) with the experimental group only, and then
administrates a post-test to assess the differences between the two groups. This particular quasi-experimental design was chosen for this study.

4.2 Design of this study

This study seeks to investigate the effect that construction play (using ‘6 Bricks’ and ‘6 Bricks with exploratory talk’) has on the development of learners’ visual perception and reasoning abilities. The use of a mixed methods approach not only added valuable and diverse perspectives to this study but allowed the researcher to seek clarity and gain deeper understandings by finding convergence and collaboration of the results from a variety of data instruments. The quantitative data generated by the learners’ Visual Perceptual Aspects Test (VPAT) and the Raven’s Coloured Progressive Matrices (RCPM) was supplemented by teacher record sheet, researcher observation and teacher interview data.

The activities were conducted sequentially (sequential quantitative first timing). Pre- and post-tests (quantitative data) were administered and analysed before the teacher record sheets, researcher’s observations and teacher interviews (qualitative data) were considered. As noted earlier, emphasis was placed on the quantitative data (443 learners for the Visual Perceptual Aspects Test and 436 learners for the Raven’s Coloured Progressive Matrices tests) and the teacher record sheets, researcher’s observations and teacher interviews (qualitative data) provided supportive information to the pre- and post-tests (quantitative data) findings. The pre- and post-tests comprised of two computerized tests (test presented in digital format on a computer), namely, the Visual Perceptual Aspects Test (VPAT) and the Raven’s Coloured Progressive Matrices (RCPM). Both of the tests were originally designed as pen and paper tests, but were computerised for the purpose of this study. The reasons for computerising the tests and details of the processes undertaken to produce the computerised products are discussed in detail later in this chapter.
At each school there was a comparison group (class) and an experimental group which included two intervention sets (classes); the first focused on visual perception development via individual play using the ‘6 Bricks’ activities, while the second also focused on visual perception development via individual play but also included exploratory talk during a set number of the ‘6 Bricks’ activities. In each of the five schools the comparison group was called ‘class one’, while classes two and three served as the two experimental groups.

The same pre-post-tests were administered to each of the three groups in each school. After the intervention, in other words, after the experimental groups had received the treatment (played with the ‘6 Bricks’ and engaged in exploratory talk while playing with the ‘6 Bricks’), the post-test was written by all groups. The outcomes between the pre- and post-tests were treated statistically to evaluate if there were any statistically significant differences between the comparison and experimental groups and between the two interventions (individual ‘6 Bricks’ play activities and ‘6 Bricks’ which included exploratory talk during a set number of the play activities).

As noted before, the qualitative instruments comprised observations, teacher record sheets and teacher interviews. A semi-structured qualitative observational instrument was used when observing learners using the ‘6 Bricks’ approach (Appendix E) and a semi-structured qualitative and quantitative observational instrument was used when observing learners using the ‘6 Bricks’ approach where the teachers attempted to facilitate exploratory talk (Appendix F). Both of these instruments were developed by the researcher whose main aim was to observe learners’ involvement with the ‘6 Bricks’ and their apparent ability to visualize and engage in exploratory talk. The ‘6 Bricks’ unstructured observation instrument consisted of a single page divided in half for descriptive and reflective notes while the ‘6 Bricks with exploratory talk’ observations utilised a three point scale with space allocated for a description below each criterion observed.
The teacher record sheets helped to determine how many of the ‘6 Bricks’ and ‘6 Bricks with exploratory talk’ activities the teachers were able to complete with their respective classes. The teacher record sheets and comments also assisted to confirm or to add new aspects which the other data tools could not capture (Appendices C & D). The semi-structured interviews used explored the teachers’ understandings and perceptions of the interventions and processes in greater depth (Appendices G, H & I). Qualitative data gathered from the observations, teacher record sheets and interviews were triangulated with the quantitative data generated by the VPAT and RCPM tests.

4.3 Groundwork for the study

Firstly, I did a considerable amount of reading on topics which included play, the importance of play in early childhood, playing with concrete manipulates such as blocks and bricks, visual perceptual aspects, the importance of visual perceptual aspects for numeracy and literacy, and exploratory talk and reasoning. Eventually, I was guided by the literature to focus on the possible effect that guided play using ‘6 Bricks’ has on learners’ visual perception and reasoning abilities. Having read about the training offered by LEGO and their claims about possible enhancement of visual perception in their promotional material I contacted LEGO Denmark via email. The LEGO Head Office forwarded my details to a company in South Africa known as Care for Education which is affiliated to LEGO Denmark. In June 2014, Care for Education and Hands on Technologies invited me to attend a two-day workshop that they were running in Port Elizabeth. During this workshop I was introduced to the ‘6 Bricks’ approach developed by Brett Hutcheson, the director of Care for Education and Hands on Technologies. Between the period of June 2014 and August 2014 I found out all I could about this ‘6 Bricks’ approach, which seemed to offer opportunities for the development of visual perception and reasoning abilities.
In August 2014, I was invited by Care for Education and Hands on Technologies (South Africa, Johannesburg) to spend a week with Brett Hutcheson and his team in Johannesburg. During this time I attended ‘6 Bricks’ workshops, visited and spent time at a pre-primary school which has implemented LEGO play into their curriculum, and visited and observed a Grade 2 teacher who has implemented ‘6 Bricks’ into her daily class routine. I also had the privilege of spending quality time with Brett and his team posing questions, delving deeper and gaining a thorough understanding about the rationale for the ‘6 Bricks’ approach from the developers themselves. They also shared many resources with me including reading materials and activity books.

Once again, in May 2015, I was invited by Care for Education and Hands on Technologies to attend a two-day workshop in Durban (South Africa) where Foundation Phase teachers from rural areas were trained to use the ‘6 Bricks’ approach. Personnel from the LEGO Denmark research team were also present, which enabled me to spend time with them discussing this study as well as the workshops and training that I would conduct with the teachers who would participate in my research.

Spending quality time with the above mentioned personnel helped me to refine the focus of my study. A relationship developed between the LEGO personnel and me and I was encouraged to maintain contact and direct any queries I had to them at any given time. The LEGO Foundation donated a set of ‘6 Bricks’ which were used for the intervention play activities to every learner and teacher who formed part of my study (Appendix A).

5. METHODOLOGY

My initial aim was to find seven schools that met the criteria for participation (see below). This number was only attained after I had telephonically contacted 42 schools in the Port Elizabeth Metropolitan area. Thereafter, an appointment with the principal and Grade 2
head teacher was organised. I introduced the teachers to the ‘6 Bricks’ approach and invited them to consider participating in my study while explaining that there would be a selection process based on the following criteria:

(i) Eastern Cape Department of Education schools which follow the National Curriculum and are not unduly affected by complicating factors such as school functionality and language issues,
(ii) primary schools which employ teachers who are English first language speakers,
(iii) primary schools with diverse learner populations,
(iv) schools with three classes of Grade 2 learners,
(v) schools with functional computer laboratories for testing learners (VPAT and RCPM tests) and with sufficient computers for each learner to be seated at his/her own computer, and
(vi) schools with teachers who were committed to partaking in this study for the full duration (over most of the calendar schooling year).

5.1 Sample and setting

Seven of the forty-two schools accepted the invitation. The majority of the schools which were not included either declined due to busy school schedules or did not meet this study’s selection criteria. At the last minute, two of the seven schools withdrew, citing time constraints as the reason, leaving five schools selected as a purposive convenience sample. The issue of convenience were that these schools are all situated in the Port Elizabeth Metropole, have a relationship with the university in terms of student teacher practice and, while they register learners from a reasonable range of social class, this range is not extreme. The schools represented lower to middle class urban South African institutions. In short, they were selected as they were accessible and were deemed to be schools in which there was a reasonable chance
of achieving the aims of the study. The five primary schools which partook in the study are designated as Schools 1, 2, 3, 4 and 5 to maintain their anonymity.

Being schools that are representative of lower to middle class urban South African institutions the vast majority of the children were English second-language speakers (with isiXhosa as their home language) despite the fact that the language of teaching and learning (LOLT) in the schools is English. This language issue required that a translator be present during testing to ensure that the children fully followed all the instructions when they were being tested.

The learner sample size from these five schools was 443 (VPAT Test) and 436 (Raven’s Test) Grade 2 learners, a sample size which has a good probability of producing normally distributed data which can then be treated using parametric statistical techniques to provide robustly motivated inferential statistics (Creswell & Plano Clark, 2011). In contrast, only a small sample size is required for meaningful qualitative research that will provide in-depth information about the central concept or phenomenon being explored in the study (Creswell & Plano Clark, 2011). The qualitative idea is not to generalise but to develop an in-depth understanding from a few participants. In this study one-on-one interviews were conducted with all of the ten teachers in the experimental group.

5.2 Intervention

According to Arthur, Warning, Coe, and Hedges (2012, p. 10) “intervention research actively sets out to introduce some change into the educational world, then studies the reaction. Intervention research shares a belief in the importance of change and the view that we can really only fully understand the world if we understand how to change it.”
The intervention employed in this study primarily required teachers to engage their learners in guided play using the ‘6 Bricks’ approach. The first intervention investigated whether any visual perceptual aspects were affected when teachers completed three ‘6 Bricks’ activities per week with their learners. The second intervention included an extension of the activities during a set number (10) of ‘6 Bricks’ approach activities which included attempts by the teachers to get their learners to engage in exploratory talk.

Intervention activities

I was granted permission by Care for Education and Hands on Technologies (Appendix J) to choose and implement ‘6 Bricks’ activities from the resources they provided. I consulted these resources and identified 45 activities which I deemed to be relevant to this study. These ‘6 Bricks’ activities focused on aspects of visual perception, namely, visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S). Ten activities, which appeared to lend themselves to exploratory talk between learners when using the ‘6 Bricks’ activities because of the possible questions of interest to children that they raised, were also chosen.

Workshops

Two ‘6 Bricks’ workshops were conducted with the teachers in the experimental groups. This was done with a view to develop their understanding of the ‘6 Bricks’ approach (the intended intervention) and how to implement it with their learners. During these workshops they experienced first-hand some of the activities that they were expected to conduct with their learners. Together we designed the ‘6 Bricks’ teacher record sheet, keeping it as simple as possible at their request (Appendix C).
An additional ‘6 Bricks with exploratory talk’ workshop was held with the five teachers who were involved in the second aspect of the intervention (teachers in class three in each of the five schools). During these workshops they experienced first-hand exploratory talk activities with the selected ‘6 Bricks’ activities that they would do with their learners. This was done with a view to develop their understanding of exploratory talk provide experience on how to engage their learners in exploratory talk when using the ‘6 Bricks with exploratory talk’ approach.

Certain ground rules govern exploratory talk (Mercer et al., 1999) and it was important that the teachers understood these. They were requested to remind their learners of these rules before they commenced each exploratory talk activity. The original ground rules of Mercer et al. (1999) were re-worded by the teachers with me to a level that the teachers felt that the Grade 2 learners could understand. In addition, the teachers designed the ‘6 Bricks with exploratory talk’ teacher record sheets. They requested the record sheets have the ground rules on them so that they could use them to easily assess and record whether their groups of learners adhered to the ground rules or not (Appendix D). The re-worded ground rules were as follows: (i) everyone must think about what they have been asked to do, (ii) everyone must say what they think, (iii) it is ok to think differently, (iv) remember to be polite, (v) listen carefully to the others, and (vi) agree with the best answer.

Upon completion of the ‘6 Bricks with exploratory talk’ workshop I consulted a graphic designer from Nelson Mandela Metropolitan University who assisted in the design of exploratory talk ground rules poster for the teachers to place in conspicuous and easily visible places in their classrooms. The design was emailed to the five teachers involved with the exploratory talk aspect of the intervention and they were requested to provide feedback. The teachers acknowledged their satisfaction with the design and wordings of the poster. They only
suggested that key words be bolded. The researcher then had ten A3 size posters printed and each teacher was given two (Appendix B). They were requested to place one in front and one at the back of their classroom so that all learners could see them from wherever they were sitting in the classroom. After the workshops, the teachers were provided with enough sets of ‘6 Bricks’ for each of their learners to have their own set of ‘6 Bricks’. The teachers were also each given a set of ‘6 Bricks’ and a file containing the ‘6 Bricks’ activities and teacher record sheets. The teachers involved in ‘6 Bricks with exploratory talk’ aspect of the study received an additional ten activities to use when facilitating exploratory talk and ten exploratory talk record sheets.

5.3 Quantitative data generation

Creswell (2005) describes a pre-test as an instrument which provides a measure of some participant attribute or characteristic which the researcher assesses in an experiment before they receive some treatment. In contrast, a post-test is a measure of some participant attribute or characteristic which the researcher assesses in an experiment after the participants received some treatment. As mentioned earlier, a pre- and post-test design was used in this study with the same tests administered before and after the intervention. The researcher administered a pre-test to both the comparison and experimental groups, conducted experimental treatment activities (interventions) with the experimental groups only, and then administered a post-test to assess whether there were any differences in the change of pre-post-test scores between the two groups. The quantitative data collection instruments for the pre- and post-tests included, the Visual Perceptual Aspects Test (VPAT) and Raven’s Coloured Progressive Matrices (RCPM). Below, a description and rationale for each test is discussed separately.
5.3.1 Visual Perceptual Aspects Test (VPAT)

As aspects of visual perception are seen as facilitating functions and skills which play an important role in a prospective learner’s ability to acquire basic literacy and numeracy proficiency, South African educational psychologist, Sylvia Catherine Clutten, designed a standardised visual perception test to address the South African educational context (Clutten, 2009). Her Visual Perceptual Aspects Test (VPAT) measures distinct visual perceptual aspects of South African Foundation Phase learners ranging between five and ten years of age. After finding her Master’s study in the public domain (library), I contacted her telephonically to obtain permission to computerise and use her test (Appendix K). I also met her in person on two separate occasions during which we discussed her test in detail to ensure that I understood all of its aspects correctly.

The VPAT consists of nine individual subtests, namely, visual discrimination (VD), visual form constancy (VFC), visual memory (VM), visual sequential memory (VSM), visual spatial-relationships (VS-R), position-in-space (P-S), visual closure (VC), visual figure-ground (VF-G), visual analysis and synthesis (VA/S). Each subtest comprises of 16 items which are made up of shapes, forms or designs arranged from easy to more complex forms.

For assessment and evaluation purposes, the nine subtests have been divided into four sections, namely, (i) visual discriminatory aspects, (ii) visual memory aspects, (iii) visual spatial processing aspects, and, (iv) visual perceptual analytical aspects. Each section evaluates identified aspects of visual perception, from its simplest level (visual discrimination) to more advanced visual information processing and analytical abilities.
5.3.2 Raven’s Coloured Progressive Matrices (RCPM)

The Raven’s Coloured Progressive Matrices (RCPM) is a standardized test specifically designed for use with young children under 11 years of age (Raven et al., 1998). It was originally designed to measure ‘deductive reasoning’ in children i.e. the capacity to deduce, store and reproduce information (Van den Heuvel & Smits, 1994). As the RCPM involves the matching of a target to a pattern it is also considered to be a visuo-spatial perception test (Van Herwegen et al., 2011). Facon et al. (2011) note that the RCPM can be used with confidence in studies comparing participants with and without intellectual disability.

The RCPM is known as one of the best measures of general cognitive abilities including Speaman’s g (Lanfranchi & Carretti, 2012) and researchers have used the test to measure specific aspects of cognitive ability such as, fluid intelligence (Woliver & Sacks, 1986; Van den Heuvel & Smits, 1994), abstract reasoning and to estimate IQ (Lanfranchi & Carretti, 2012), and visuo-spatial ability (Gunn & Jarrold, 2004).

5.3.3. Computerising the VPAT and RCPM tests

The VPAT and RCPM tests are pen and paper tests. The sample size of this study was large (VPAT = 443 and RCPM = 436). To test each learner individually would be very time-consuming, and there was also the possibility of the data being inaccurately manually recorded. Teachers were not prepared to sacrifice their teaching time to administer and mark tests because of their rigorous school schedules and were not asked to do so as they are not researchers or psychologists. Based on the above, it was concluded that it would be best if computerized versions of the VPAT and RCPM tests be developed that organised the data automatically in a way that they were easily analysed statistically.
As noted earlier, permission was obtained from Sylvia Clutten for the development of a computerized version of the VPAT test (Appendix K). NCS Pearson is the agent and copyright holder of the RCPM Matrices test. Permission for the development of a computerized version of the RCPM was obtained from NCS Pearson upon the payment of a fee (Appendix Q).

Once the five schools consented to being part of the study, the computer teacher of each school was contacted and an appointment set up between the computer teacher, a system analyst and myself. This visit allowed me to evaluate the computer laboratory and environment and the system analyst to identify if the infrastructure and the necessary computer components not only existed, but were also functional. After consultation and planning, the system analyst and I identified the necessity of five crucial components to effectively run computerized versions of the VPAT and the RCPM at the schools. These five components were:

(i) Server: Since the sample size of this study is large (VPAT = 443 and RCPM = 436) and whole classes will complete the tests at the same time (+/- 30 learners per class), the installation of a database on the server of each school was imperative. The main purpose of the database is to safely store essential information that is easily accessible in one place. This essential information to be stored on one database includes learners’ biographical information, the VPAT and RCPM tests content and learners’ results. Upon completion of the tests, learners’ results will immediately be transferred to the database where it will be saved and then exported into an excel sheet for analysis at a later stage. In addition, the database will allow the researcher to export data of all three classes at each school, an entire class or just a select number of learners. However, the server must be connected to the network, so the researcher and learners can communicate and collaborate.
(ii) Connectivity: In order to deliver the VPAT and RCPM tests content from the server to the learners’ computers, connectivity mechanisms had to be investigated and identified. Connectivity permits the access and exchange of data between computers (Emmanouilidis, Koutsiamanis, & Tasidou, 2013). Different connectivity mechanisms are used within industry such as Local Area Network (LAN) and Wi-Fi (Challoo, Oladeinde, Yilmazer, Ozcelik, & Challoo, 2012). The visits revealed that three of the schools had old computers which only worked with LAN connectivity while the remaining two schools did not have Wi-Fi. The systems analyst and I concluded that the most practical connectivity for all the schools would be the LAN connectivity.

(iii) Tester application: The VPAT is made up of nine different subtests. Each subtest requires a different explanation and set of instructions to be given by the researcher to the learners before they begin a new subtest. It therefore required a tester application. The main role of the tester application is to present to learners the first two items of each subtest, provide them with an explanation and set of instructions for that particular subtest and then to ensure they understand what is required of them. The tester application also assisted me to observe the learners’ results immediately and determine who had or had not completed the nine subtests.

The RCPM comprises of one test made up of 36 items which learners completed one after the other. However, a tester application was also required as the main role of the tester application was to present to learners the first four items of the RCPM and provide them with the necessary explanation and set of instructions.

(iv) Learner application: The learner application communicated with the tester application via the server. Similar to the tester application, it assisted me to observe the learners’ results immediately and determine who had or had not completed the test. The learner application was installed on every computer so that each learner could work
individually. Once the learner logged in, the learner application retrieved the test from
the server. Upon completion of the test, the results of each learner was immediately
recorded and saved on the server.

Since the VPAT consists of nine subtests, the learner application differed slightly. Once
the learner logged in, the learner application retrieved the first subtest from the server.
Upon completion of the first subtest, the results of each learner was immediately
recorded and saved on the server. This process continues for each of the nine subtests.
In addition, the learner application had a timer. Learners had an allocated time within
which to choose an answer (see Chapter Two, Section 3.1.1) for each of the subtests
items. If they did not choose an answer for an item within the allocated time, the item
for that particular subtest was automatically recorded as incorrect and the next item was
immediately displayed.

(v) Presentation Application: The presentation application was installed on the server. Due
to time constraints and the difficulty of explaining the test instructions to each learner,
a data projector was used. The presentation application was controlled and managed by
the tester application which enabled me to move between the slides while explaining
the first few items. To ensure that learners understood what was expected of them, the
first two items from each of the nine VPAT subtests and the first four items of the
RCPM test was shown and explained to them.

*Piloting the computerised VPAT and RCPM tests*

A researcher may plan his/her investigation very carefully and logically but the
practical situation, unless entered, will remain an unknown factor. A pilot study can be viewed
as the prelude to the main investigation, though on a smaller scale (Basit, 2010; de Vos et al.,
2011). It has also been described as a procedure for testing and validating an instrument by
administering it to a small group of participants from the intended test population (Barker,
Those who participate in the pilot study should not participate in the main inquiry (Rubin & Babbie, 2005; Unrau, Gabor, & Grinnell, 2007). The sample, approach, methodology and methods used in the pilot study ought to be reflected in the actual study at a later stage (Basit, 2010).

In this research project a pilot study was conducted in School 1’s computer laboratory during early April 2015. The researcher accompanied by the technician and a foundation phase teacher (who is fluent in isiXhosa and has teaching experience) assisted in the administering of both the VPAT and RCPM tests. The learner application was installed by the technician on each participant’s computer. The teacher/tester application was installed on another computer from which the researcher could control and manage the testing process. A data projector was set up so the researcher could display the first two examples from each of the nine VPAT subtests and the first four examples of the RCPM test for the group of children being tested.

The explanations and set of instructions for both the VPAT and RCPM tests are in English and were shared prior to the pilot study with a native isiXhosa speaker who would assist with translations. The explanations and sets of instructions for both the VPAT and RCPM tests were given to the participants prior to the testing, in English by the researcher and then verbally translated into isiXhosa by the translator. All questions posed by learners in English or isiXhosa were answered. Participants then completed the tests. The piloting of both the VPAT and RCPM tests were conducted within an hour. During this time, I observed the learners and made field notes.

The pilot study revealed that the system was stable before the actual testing took place and most of the technical issues identified and corrected during the pilot study were common to both the VPAT and RCPM tests. The pilot study was also an opportunity to observe the behaviour of the participants while using the computerised versions of the VPAT and RCPM
tests and to determine whether they understood the explanation and set of instructions given to them in both English and isiXhosa.

All the participants began the VPAT test at the same time. The ceiling for each of the nine subtests is three consecutive unsuccessful attempts. This meant that depending on each participant’s ability, some completed the subtest long before others. Instead of waiting for the other participants to also finish, they began the next subtest without getting the necessary explanation and set of instructions for the next subtest. This meant that participants were each completing a different subtest without understanding exactly what was required from them for each of the subtests. It was also impossible for the researcher to go to each participant and verify whether he/she had completed each of the nine subtests.

As such, a new feature was added to the teacher application to ensure management and control at the start of each of the nine subtests. The feature displayed the name of the current subtest and three buttons labelled as ‘next’, ‘previous’ and ‘start’. The ‘next’ and ‘previous’ buttons allowed me to navigate easily between the subtests. The ‘start’ button was a communication mechanism between the teacher application and learner application via the server. Once I pressed the ‘start’ button, the tester application stored a subtest number in the database. Once a participant completed the first subtest and clicked on the ‘next’ subtest, the learner application would send a query to the server to ensure that the requested subtest number matches the subtest number currently stored in the database. If the subtest numbers did not match, a prompt ‘wait for your teacher’ would appear on their screens which disabled them from starting the next subtest. This assisted me to verify whether or not all participants had completed the subtest. In addition, because the ‘start’ button was controlled by me, I dictated when participants began the next subtest. Participants had to wait for the others to finish and then receive the necessary explanation and set of instructions. Only once I was satisfied that the participants understood what was expected of them, was the start button clicked and
participants permitted to begin the next subtest, all at the same time. The tester application was therefore considered a vital component to ensure management and control of the VPAT by me.

Another shortcoming was that some participants were in a rush, clicking the mouse two to three times without thinking before carefully choosing an answer. By clicking two to three times, they were immediately taken to the second or third item as the viewing period per item was one second. This posed a problem as the ceiling for each of the nine subtests is three consecutive unsuccessful attempts. To solve this problem, the learner application was modified by building in a system where participants had to view an item for a minimum of three seconds before it moved to the next item.

While completing the RCPM test, some of the participants mistakenly clicked the exit button before completing the test which meant that their results were unsaved. To accommodate this shortcoming and ensure that all results were saved, the learner application was modified. Once a participant clicked the exit button, a confirmation message appeared on the screen asking ‘are you sure you want to exit?’ Seeing this message, the researcher would then go to that participant’s computer and verify whether or not he/she had completed the entire test. If the entire test was completed, the researcher would press ‘yes’ and exit the test or press ‘no’ and allow the learner to resume from the last item where he/she stopped.

Participants were required to fill in their biographical data such as their name, surname, class number and birthday which took them much longer than expected. The researcher was allocated a set period of time within which to complete testing at each of the schools. To overcome this problem, the technician and I entered the biographical data of each participant and then seated them at their respective computers. Although the name and surname of each participant was entered, the system generated a unique identity number for each participant.
Re-piloting the computerised VPAT and RCPM tests

The main aim of the re-piloting was to determine whether or not the solutions proposed and modifications made to the shortcomings detected during the piloting were successful or not. Re-piloting was conducted during the latter part of April 2015. As mentioned earlier, School 1 had an extra Grade 2 class from which nine learners served as participants for the pilot study. Another nine other learners from this extra class served as participants for the re-piloting. The procedure for the re-piloting was exactly the same as the piloting. The solutions proposed and modifications made to the shortcomings detected during the piloting proved satisfactory. Both, the technician and I were satisfied and decided to commence the actual testing.

Actual testing

The computer teacher of each school was contacted and an appointment set up between the technician, the computer teacher and me. The five crucial components to effectively run computerised versions of the VPAT and the RCPM were explained and discussed as well as the testing procedure. It was also an opportunity to address any concerns and queries raised by the computer teachers. The computer teachers were then requested to discuss the installation and testing process with relevant school personnel and then contact the researcher.

Once the schools were satisfied and consented to the installation, a day, date and time was agreed upon for the technician to visit the schools. The server, learner, teacher and presentation applications were installed by the technician at all the schools a week prior to the actual testing. As mentioned earlier, three groups of Grade 2 learners from five primary schools participated in the VPAT (n=443) and RCPM (n=436) tests. I was accompanied by the technician, psychology students in their Honours’ year of studies and a Foundation Phase teacher fluent in isiXhosa served as an isiXhosa translator assisted in the administering of the
tests. The testing took place during the usual computer lessons or at a time proposed by the schools’ computer teachers, depending on the availability of the computer laboratories. The class teachers and the computer teachers at each school availed themselves during the testing to assist with any queries that arose.

The testing procedure at each of the five schools was exactly the same as the process used during re-piloting with the only difference being the number of learners per class. Biographical data of each learner was entered by the technician and me, after which the learners were seated at their respective computers. Explanations and instructions were given to the learners in English by me and then in isiXhosa by the translator. All questions posed by learners in English or isiXhosa were answered. Once I was satisfied that the learners understood what was expected of them, were they allowed to begin the tests. As the RCPM is a psychological test, Professor Hoelson of NMMU’s Psychology department was consulted and he organised 8 Honours level psychology students to accompany and assist with the testing.

The two pre- and post-tests were administered a week apart; with learners first completing the RCPM followed by the VPAT test. Together, the personnel mentioned above and I revisited each school after the pre- and post-testing to test those learners who were absent on the scheduled days. A few learners left the schools during the course of the year and therefore did not participate in the post-tests. These learners’ pre-test results were deleted upon the advice of the statistician. Pre-testing was conducted during the month of May, 2015, while post-testing was conducted towards the latter part of November and early part of December, 2015.
5.4. **Qualitative data generation**

The qualitative data gathering instruments were referred to under the design section earlier in this chapter and only brief comments will be made for further clarity at this stage.

**5.4.1 Teacher record sheets**

The teacher record sheets were developed primarily to ascertain which activities had been carried out in each of the five participating schools. The record sheets were different for ‘6 Bricks’ (Appendix C) and for ‘6 Bricks with exploratory talk’ (Appendix D) in that additional data were required to assess the exploratory talk aspect. Teachers were requested to complete a new record sheet after each activity. As noted earlier, during the consensual development of the record sheets the teachers wanted to keep them as simple as possible as they did not want to be burdened with any additional paperwork.

The ‘6 Bricks’ record sheet consisted of spaces made available for the teacher to record the date, the activity’s name, the number of bricks used for that particular activity, whether learners understood the activity, whether learners were able to complete the activity and whether they enjoyed the activity. An additional space was provided for those teachers who wished to note any comments. The ‘6 Bricks with exploratory talk’ record sheet consisted of spaces made available for the teacher to record the date, the activity’s name, exploratory ground rules and a key which she used to assess whether or not the groups of learners adhered to the exploratory talk ground rules.

Apart from determining how many of the ‘6 Bricks’ and ‘6 Bricks with exploratory talk’ activities the teachers completed with their respective classes, the record sheet also helped raise awareness in terms of the successes attained and of potential problem areas that might
have risen. It also provided insight as to whether learners were able to discuss, share ideas and engage in dialogue as indicators of the children’s level of exploratory talk.

5.4.2 Observations

As this study was explorative, observations were considered to be a suitable way of gathering data on the level at which learners engaged with the ‘6 Bricks’. Three classroom observation visits were made to each teacher who participated in the intervention involving the ‘6 Bricks’ approach and a further three visits were made to those teachers who participated in the intervention involving ‘6 Bricks with exploratory talk’. The teachers were consulted and suggested the date, day and time for each observation. I sought confirmation closer to the proposed date. All observations were conducted during school hours in the teachers’ respective classrooms. I was introduced by the teacher to the class along with an explanation that I wanted to see what happens in the classroom when they played with the LEGO bricks.

The observational protocols (Appendix E) consisted of a single page with a dividing line down the middle to separate ‘descriptive notes’ from ‘reflective notes.’ ‘Descriptive notes’ record a description of the events, activities and people while ‘reflective notes’ record the researcher’s personal thoughts, such as speculation, feelings, ideas, hunches, impressions, or broad ideas and themes that emerge during the observation (Creswell, 2005; 2009). In addition, ‘demographic information’ about the time, place, and date of the field setting where the observation took place might also be included on this page (Creswell, 2009). The main aim of the observation was to observe learners’ involvement with the ‘6 Bricks’; their apparent ability to visualize, listen and follow instructions, focus and concentrate on the activity, and lastly their ability to complete the activity.

A three point scale was incorporated in the design of the semi-structured observation instrument which included exploratory talk (Appendix F). The main aim of the observation
was to derive qualitative data relating to exploratory talk by observing learners in their groups which included their adherence to the exploratory talk ground rules, their ability to discuss and share ideas and engage in dialogue, their level of exploratory talk and lastly their ability to complete the activity.

5.4.3 Teacher interviews

Interviews are the most prominent data collection tools in qualitative research (de Vos et al., 2011) and one of the most powerful ways we have of understanding others (Punch, 2009). Gay and Airasian (2000) mention that interviews permit the researcher to obtain data that cannot be obtained from observations and allows one to explore and probe participants’ responses to gather more in-depth data regarding their experiences, feelings, attitudes, interests and concerns. Open-ended questions allow the participant to best voice their experiences and opinions unconstrained by any perspectives of the researcher or past findings (Creswell, 2005). Semi-structured interviews are much more structured but still flexible. The interviewer has a set of predetermined interview questions on an interview schedule, but the interview is guided rather than dictated by the schedule (de Vos et al., 2011).

A semi-structured interview protocol was used in this study. Ten interviews were conducted, one each with the teachers who participated in the intervention involving ‘6 Bricks’. A further five interviews were conducted with those teachers who participated in the intervention involving ‘6 Bricks with exploratory talk’. The interview date, time and venue were scheduled well in advance and I sought confirmation closer to the proposed date of each interview. All interviews were conducted after school, upon dismissal of their Grade 2 learners. The teachers chose their classrooms as the interview venues which they thought to be a quiet environment which in turn facilitated the interview process with no interruptions.
I briefly explained the purpose of the interview and asked whether the interviewees had any questions or concerns prior to the interview. Informed consent was sought and interviewees were assured that their responses would remain anonymous. All the interviews were conducted during the months of February and March, 2016, recorded on a dictaphone and transcribed (McMillan & Schumacher, 2006).

6. DATA ANALYSIS

Data analysis requires the reduction and interpretation of information collected (Johnson & Christensen, 2008). Analysis consists of ‘taking the data apart’ to determine individual response and then ‘putting it together’ to summarise it (Creswell, 2005). Analysing and interpreting the data “indicates that researchers analyse the data, represent it in tables, figures, and pictures, and explain it to come up with answers to research questions and statements asked in the research” (Creswell, 2005, p. 588).

Quantitative data are seen as offering precision whereas qualitative data are viewed as presenting depth (Basit, 2010). In a mixed method research approach, the data are analysed separately. Quantitative data is analysed using quantitative analysis and qualitative data is analysed using qualitative analysis (Creswell, 2005).

6.1. Quantitative data analysis

Statistics are used to analyse quantitative data which involves comparing group differences or describing trends (Creswell & Plano Clark, 2011), and looking for similarities and differences, patterns, distribution, significance and correlation (Basit, 2010). The data are then presented by means of exact figures gained from precise measurement (du Plessis & Majam, 2010). As noted earlier, the quantitative data from the VPAT (n=443) and RCPM (n=436) were scored and captured onto a Microsoft Excel spreadsheet. Statistical analysis was
undertaken in consultation with a statistician from the Nelson Mandela Metropolitan University’s Statistical Support Unit.

Descriptive and inferential statistics were employed in the analysis and interpretation of data. Descriptive statistics make no inferences or predictions (Cohen et al., 2007). They simply focus on describing, summarising, explaining and presenting the data, indicating general tendencies in the data, spread of scores and a comparison of how one score relates to another (Creswell, 2005; Johnson & Christensen, 2008). Inferential statistics goes beyond the immediate data and uses the laws of probability to make inferences and draw statistical conclusions based on the data gathered (Johnson & Christensen, 2008). They enable the researcher to draw conclusions and generalisations from a sample to a population of participants (Creswell, 2005). The tests used in this study included the $\chi^2$ test, t-test for assessment of differences, analysis of variance (ANOVA), and Cohen’s $d$ measure of practical significance where statistically significant differences were determined.

6.2. Qualitative data analysis

Qualitative data analysis is eclectic and there is no single ‘right’ way of analysing data (Johnson & Christensen, 2008). In this study the data generated in the form of verbatim quotations were coded, dividing the text into small units (phrases, sentences, or paragraphs), assigning a label to each unit, and then grouping the codes into themes. The coding label usually comes from the exact words of the participants or phrases composed by the researcher (Creswell & Plano Clark, 2011). Qualitative data derived from the teacher interviews were inspected, categorised and then analysed thematically according to the Tesch method (Creswell, 2005). During this inductive and descriptive analysis, the researcher adhered to the steps of Tesch, as listed in Creswell (2005, p. 238). Briefly, these steps involved (i) reading all the transcripts several times and making notes of themes that emerge, (ii) grouping similar
themes together and breaking up themes into main theme, categories and sub-categories, (iii) assigning codes to the themes and noting these next to the appropriate text to provide verbatim quotes and (iv) grouping together the data belonging to each category and then individually analysing them.

An independent re-coder, who had no involvement in the research, accepted the responsibility of independently coding the data concurrently with me and followed the same steps of Tesch. A discussion was then held between the two of us in order to reach consensus and determine the final themes. According to Leedy and Ormrod (2001) using an independent re-coder ensures triangulation which added to the validity of the qualitative data. Data generated via teacher interviews were used to determine the teachers’ perceptions regarding visual perception, exploratory talk and the ‘6 Bricks’ approach. These data were inspected, themed and coded.

7. RELIABILITY AND VALIDITY

Cohen et al. (2007) explain that the concepts of reliability and validity are essential to the research process. Reliability is a necessary prerequisite to validity, meaning that research which is valid is always reliable but reliable data are not necessarily valid (Johnson & Christensen, 2008). Both reliability and validity can be applied to quantitative and qualitative research approaches but differ in definition (Golafshani, 2003). As this study adopted a mixed method approach, reliability and validity are discussed from both a quantitative and qualitative perspective.

7.1. Reliability and validity in quantitative research

Quantitative reliability means that results/scores obtained from the instrument administered are accurate, stable and consistent (Creswell, 2005). For the research to be reliable
it must demonstrate that if it were to be carried out at different times with similar participants in a similar context, the same or nearly the same results will be achieved (Cohen et al., 2007). Reliability is concerned with precision and accuracy (Basit, 2010) and is usually calculated using statistical analysis (Mertens, 2005). In this study the quantitative tests that were used have been proven to be reliable and, as such, there was no need to analyse the internal consistency of the tests using a measure such as Cronbach $\alpha$.

Validity is related to the accuracy of the instrument, such that the instrument measures what it was intended to measure, allowing the researcher to draw meaningful and justifiable conclusions from the sample being studied to the population (Creswell, 2005; Punch, 2009). Validity is therefore significant in research as it confirms that the actual outcome of the research is in relation to the objectives set in the beginning (Basit, 2010). Again, in this study, the quantitative research instruments included nationally and internationally recognised tests, the VPAT and RCPM tests, and as such, are considered to be valid for their purpose.

### 7.2. Reliability and validity in qualitative research

Qualitative reliability is unique, particular to a setting and does not aim to duplicate (Basit, 2010). Reliability is synonymous with terms such as ‘credibility,’ ‘dependability’ and ‘trustworthiness’ (Lincoln & Guba, 1985). Neuman (2003) also suggests that reliability has to do with the issue of dependability. Dependability of data in this study was established by capturing all the teacher interviews on a dictaphone for transcription. Attempts were made to reproduce the interview scripts as accurately as possible to eliminate possible threats to the reliability of the instruments used in this study.

Qualitative researchers adhere to the core principle of validity, to be truthful (and avoid false or distorted accounts). Qualitative validity means that the researcher checks for accuracy
(Creswell, 2009). These techniques include; checking transcripts for possible mistakes made during the initial transcription, creating lists of codes to prevent drift in the definition of codes, and cross-checking codes developed within the existing literature by comparing results that are independently derived (Creswell, 2009). Basit (2010) contends that triangulation is a helpful strategy to check not just the validity but also the reliability of data.

In this study, the qualitative data in the form of teacher interviews provided appropriate descriptions. A prolonged time was spent in the classrooms and repeated observations were made to further develop an in-depth understanding of the phenomenon under study. This procedure enabled me to observe the participants in their natural setting which ensured more accurate or valid qualitative findings. Triangulation was achieved by corroborating the quantitative (pre- and post-tests) and qualitative data (teacher record sheets, researcher observations and teacher interviews).

8. **ETHICAL ISSUES**

Basit (2010) asserts that since most educational research deals with human beings, ethical considerations are extremely important. Researchers need to ensure that the research is conducted in an ethical manner. In general, ethics are considered to deal with beliefs about what is right or wrong, proper or improper, good or bad (McMillan & Schumacher, 2006).

Babbie and Mouton (2008) write that researchers have a duty and obligation to abide by the code of conduct that governs most professions. Some of the principles most relevant to educational research published by the American Educational Research Association and the American Psychological Association are (i) the researcher of the study is responsible for the ethical standards to which the study adheres, (ii) the researcher should inform the participants of all aspects of the research, (iii) the researcher should be as open and honest with the
participants as possible, (iv) the participants must be protected from physical and mental discomfort, harm, and danger, (v) the researcher should secure informed consent from the participants prior to their participation in the research, (vi) information obtained from the subjects must be held confidential, and (vii) the researcher should provide participants with the opportunity to receive the results (McMillan & Schumacher, 2006). Neuman (2003) maintains that even when research subjects are unaware of, or uninterested in ethics, they still have a moral and professional obligation to remain ethical. Researchers enter into the private lives of their participants when conducting social research (Berg, 2001) and therefore have to ensure that the privacy, rights and welfare of their participants are guaranteed (Kumar, 1999).

Bearing in mind all of the above and the accepted professional ethics of research such as honesty, integrity, fairness, respect, privacy, confidentiality, anonymity and informed consent (Creswell, 2009), I communicated and discussed the aims of the study, as well as the research design and methodologies with the principals, computer teachers and Grade 2 teachers prior to any data collection. The principals from the five participating schools, as well as the teachers who participated in the study (observed and interviewed) signed indemnity and consent forms (Appendices N & P).

Active consent was sought from the parents of the Grade 2 learners as they fall into the category of minor participants. Minors are presumed to be incompetent to make decisions and give consent (Johnson & Christensen, 2008). A letter containing information about the researcher, pre- and post-testing and the intervention activities was sent home with every Grade 2 learner. In addition, the parents were assured that their child would be assigned a number (no names would be used) and that the data would remain anonymous and confidential (Appendix O). Once consent was obtained from the parents, assent was elicited from the minors. All participants, teachers, parents and learners were aware that their responses would be used for research purposes. The test results of the individual children were not available to the teachers.
and the data analysts were not privy to the learner’s names (only numbers). The right to seek full disclosure regarding the research study as well as the overall results of the study were also guaranteed for all stakeholders.

Ethics approval was applied for and granted by the Faculty of Education Research, Technology and Innovation Committee of the Nelson Mandela Metropolitan University (NMMU) on the 14 November 2014. The ethics clearance reference number is H14-EDU-ERE-014 (Appendix L). The Eastern Cape Department of Education granted permission to undertake research in the named schools on the 14 April 2015 (Appendix M).

9. **CHAPTER SUMMARY**

In this chapter the nature of paradigmatic pragmatism and using mixed-method approaches are discussed. The rationale for using the mixed-method approach chosen for this study is also explained. The study design is quasi-experimental as pre-post-testing was employed using pre-determined and intact class experimental and comparison groups. The Visual Perceptual Aspects Test (VPAT) and Raven’s Coloured Progressive Matrices (RCPM) tests were used as a pre-test for all participants. Interventions were designed to enable teachers to use the ‘6 Bricks’ (guided play alone and guided play with exploratory talk) as experimental groups.

After a 6 month intervention period the Visual Perceptual Aspects Test (VPAT) and Raven’s Coloured Progressive Matrices (RCPM) tests were again administered as post-tests to all participants (i.e. everyone in the comparison and experimental groups). The pre- and post-tests were administered in a computerized format that was specifically developed for this study. In other words, the VPAT and the RCPM tests were presented in a digital format on computers that could be controlled administratively by the researcher, and which allowed all of the data
generated to be formatted in a way that allowed for immediate statistical analysis. Using this method over 440 matched pair pre-post-test data sets were generated. These learner pre-post data were analysed statistically to investigate any possible changes in the learners’ visual perception and reasoning abilities which might be attributed to the interventions. The computerising, piloting, re-piloting and the actual testing of the VPAT and RCPM tests were described in detail in this chapter.

The study took place in five government schools which were similar in terms of size and learner diversity. Each school had at least three Grade 2 classes. One class was used as a comparison group while the other two classes formed the experimental groups. After pre-testing the learners, the experimental group teachers participated in workshops on guided play using the sets of ‘6 Bricks’ that had been provided (these teachers and their learners were designated as classes two and three in each of the five schools). Class three teachers in each of the schools were also trained to facilitate exploratory talk when using their sets of ‘6 Bricks.’

As the pre-post-tests were conducted first, and the quantitative data they generated were analysed before any qualitative data were analysed, the study can be said to have employed an explanatory sequential mixed-method design. The qualitative data generated from teacher record sheets, observations and teacher interviews were weighed against the descriptive and inferential statistics generated via the pre- and post-tests to increase the validity and trustworthiness of the results.

Any study that includes teachers and young children raises a number of ethical issues. These issues were highlighted and discussed, and the processes adopted to ensure that the research was carried out in an ethical way were explained and clarified.
CHAPTER FOUR
RESULTS

1. INTRODUCTION

In this chapter the results from the analyses conducted on the quantitative and qualitative data generated are presented in an attempt to answer the research question Does construction play in the forms of guided play and guided play that employs exploratory talk using the ‘6 Bricks’ approach develop learners’ visual perception and reasoning abilities? Quantitative data generated from learners’ pre- and post-tests were scored and analysed statistically in order to provide both descriptive and inferential statistics. Results are presented, where appropriate, in tabular or graphical form for ease of reading, with the larger tables and original detailed statistical reports in Folders 1 and 2 of the attached Compact Disc [CD]. Qualitative data were obtained from three instruments; the teacher record sheets, observation schedules and the semi-structured, open-ended teacher interviews. The interviews were transcribed, interpreted, and coded, and where appropriate, relevant direct quotations are presented in this chapter.

Quantitative data generated from the Visual Perceptual Aspects Test (VPAT) and the qualitative data relating to visual perceptual aspects are presented first in this chapter. Thereafter, quantitative data generated from the Raven’s Coloured Progressive Matrices and the qualitative data relating to reasoning and exploratory talk are presented. Lastly, teachers’ perceptions regarding the ‘6 Bricks’ approach is discussed.
2. SCHOOLS AND PARTICIPANTS

Five primary schools within the Port Elizabeth district participated in this study, all of which follow the prescribed South African National Curriculum. For the sake of anonymity, the schools are referred to as Schools 1, 2, 3, 4 and 5. Schools 1 and 3 are strong-performing, well-resourced schools situated in mid-affluent communities drawing learners from middle-class families. Schools 2, 4 and 5 are average performing, well-resourced schools situated in lower-middle class communities drawing learners from lower-middle working class families. Almost all of the learners are English second language learners. From these five schools, a total of 443 Grade 2 learners served as the subjects for the Visual Perceptual Aspects Test quantitative data collection and 436 learners served as subjects for the Raven’s Coloured Progressive Matrices quantitative data collection. The reason for this difference in number was because seven learners were absent from class on the days set aside for either the pre or post-testing using the RCPM tests. As noted earlier, the visual perceptual aspects of the study are presented first and then the exploratory talk findings. Teacher record sheets, observation schedules and ten semi-structured teacher interviews (classes 2 and 3 teachers) provided qualitative data for both aspects of the study.

3. BIOGRAPHICAL INFORMATION

A biographical section was completed for each learner before testing began. Information required included their name and surname (after which a unique identity number was generated by the system for each participant), gender, age, home language, whether this was their first or second time in Grade 2, whether they wear prescription lenses or not and whether they are ADD, ADHD, ADD and medicated, ADHD and medicated. The distribution of learners by school and by class who participated in the Visual Perceptual Aspects Test are displayed in Figures 4.1. and 4.2. respectively. Tables 4.1 to 4.6 represent the distribution of
learners according to gender, age, home language, whether this was their first or second time in Grade 2, whether they wear prescription lenses or not and whether they are ADD, ADHD, ADD and medicated, ADHD and medicated, respectively.

Figure 4.1: *Graphical representation of the distribution of learners by the five participating schools who served as subjects for the VPAT quantitative data collection.*

Figure 4.2: *Graphical representation of the distribution of learners by class in the five participating schools which served as subjects for the VPAT quantitative data collection.*
3.1 Gender distribution

Table 4.1

Gender distribution of learners per school as a number and percentage (n = 443)

<table>
<thead>
<tr>
<th>School</th>
<th>Male</th>
<th>Male %</th>
<th>Female</th>
<th>Female %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>37</td>
<td>53</td>
<td>33</td>
<td>47</td>
<td>70</td>
</tr>
<tr>
<td>School 2</td>
<td>34</td>
<td>48</td>
<td>37</td>
<td>52</td>
<td>71</td>
</tr>
<tr>
<td>School 3</td>
<td>47</td>
<td>53</td>
<td>41</td>
<td>47</td>
<td>88</td>
</tr>
<tr>
<td>School 4</td>
<td>58</td>
<td>49</td>
<td>60</td>
<td>51</td>
<td>118</td>
</tr>
<tr>
<td>School 5</td>
<td>43</td>
<td>45</td>
<td>53</td>
<td>55</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>219</td>
<td>49 %</td>
<td>224</td>
<td>51 %</td>
<td>443</td>
</tr>
</tbody>
</table>

3.2 Age distribution

Table 4.2

Age distribution of learners per school as a number and percentage (n = 443)

<table>
<thead>
<tr>
<th>School</th>
<th>Age 7</th>
<th>Age 8</th>
<th>Age 9</th>
<th>Age 10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>0</td>
<td>61</td>
<td>9</td>
<td>0</td>
<td>70</td>
</tr>
<tr>
<td>School 2</td>
<td>1</td>
<td>62</td>
<td>8</td>
<td>0</td>
<td>71</td>
</tr>
<tr>
<td>School 3</td>
<td>0</td>
<td>77</td>
<td>11</td>
<td>0</td>
<td>88</td>
</tr>
<tr>
<td>School 4</td>
<td>0</td>
<td>92</td>
<td>25</td>
<td>1</td>
<td>118</td>
</tr>
<tr>
<td>School 5</td>
<td>0</td>
<td>81</td>
<td>15</td>
<td>0</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>1 (1%)</td>
<td>373 (84%)</td>
<td>68 (14%)</td>
<td>1 (1%)</td>
<td>443</td>
</tr>
</tbody>
</table>

As indicated in Table 4.2, 441 learners fell within the 8-9 years age group in the participating schools. This is the expected age range of Grade 2 learners. Schools 2 and 4 were the only schools with a 7 and 10 year old learner.
3.3 Home language distribution

Table 4.3

Home language distribution of learners per school as a number and percentage (n = 443)

<table>
<thead>
<tr>
<th>School</th>
<th>English</th>
<th>Afrikaans</th>
<th>isiXhosa</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>56</td>
<td>1</td>
<td>12</td>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>School 2</td>
<td>11</td>
<td>0</td>
<td>60</td>
<td>0</td>
<td>71</td>
</tr>
<tr>
<td>School 3</td>
<td>80</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>88</td>
</tr>
<tr>
<td>School 4</td>
<td>13</td>
<td>0</td>
<td>105</td>
<td>0</td>
<td>118</td>
</tr>
<tr>
<td>School 5</td>
<td>41</td>
<td>0</td>
<td>55</td>
<td>0</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>201(44%)</td>
<td>3(2%)</td>
<td>238(53%)</td>
<td>1(1%)</td>
<td>443</td>
</tr>
</tbody>
</table>

As shown in Table 4.3, majority of the learners in Schools 1 and 3 have English as their home language whereas in Schools 2, 4 and 5 it is isiXhosa. In the overall sample, a similar number of learners have English or isiXhosa as their home language. Only three learners indicated Afrikaans as their home language and one learner indicated ‘other’.

3.4 Distribution of learners’ first or second time in Grade 2

Table 4.4:

Distribution of learners first or second time in Grade 2 per school as a number and percentage (n = 443)

<table>
<thead>
<tr>
<th>School</th>
<th>1st Time</th>
<th>2nd Time</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>69</td>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>School 2</td>
<td>66</td>
<td>5</td>
<td>71</td>
</tr>
<tr>
<td>School 3</td>
<td>86</td>
<td>2</td>
<td>88</td>
</tr>
<tr>
<td>School 4</td>
<td>108</td>
<td>10</td>
<td>118</td>
</tr>
<tr>
<td>School 5</td>
<td>90</td>
<td>6</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>419(95%)</td>
<td>24(5%)</td>
<td>443</td>
</tr>
</tbody>
</table>
As shown in Table 4.4, 95% of the learners were in Grade 2 for the first time. The 5% who were repeating Grade 2 were from Schools 2, 4 and 5. This is expected as these schools are low-average performing schools drawing learners from low socio-economic groups.

### 3.5 Distribution of learners’ wearing prescription lenses or not

Table 4.5

*Distribution of learners’ wearing prescription lenses or not per school as a number and percentage (n = 443)*

<table>
<thead>
<tr>
<th>School</th>
<th>Not Wearing</th>
<th>Wearing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>65</td>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td>School 2</td>
<td>70</td>
<td>1</td>
<td>71</td>
</tr>
<tr>
<td>School 3</td>
<td>78</td>
<td>10</td>
<td>88</td>
</tr>
<tr>
<td>School 4</td>
<td>113</td>
<td>5</td>
<td>118</td>
</tr>
<tr>
<td>School 5</td>
<td>86</td>
<td>10</td>
<td>96</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>412(93%)</strong></td>
<td><strong>31(7%)</strong></td>
<td><strong>443</strong></td>
</tr>
</tbody>
</table>

As indicated in Table 4.5, only 7% of the learners from the five participating schools wear prescription lenses.
3.6 Distribution of learners’ medical background information

Table 4.6

Distribution of learners’ background information as a number and percentage (n = 443)

<table>
<thead>
<tr>
<th>School</th>
<th>Nothing</th>
<th>ADD</th>
<th>ADHD</th>
<th>ADD and medicated</th>
<th>ADHD and medicated</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>62</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>70</td>
</tr>
<tr>
<td>School 2</td>
<td>65</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>71</td>
</tr>
<tr>
<td>School 3</td>
<td>76</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>1</td>
<td>88</td>
</tr>
<tr>
<td>School 4</td>
<td>115</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>118</td>
</tr>
<tr>
<td>School 5</td>
<td>91</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>409(92%)</td>
<td>2(0.5%)</td>
<td>3(0.5%)</td>
<td>17 (4%)</td>
<td>12(2%)</td>
<td>443</td>
</tr>
</tbody>
</table>

As indicated in Table 4.6, only 7% of the learners from the five participating schools are ADD, ADHD, ADD and medicated, ADHD and medicated.

Summary of the biographical data

- There were an almost equal number of male and female participants (49:51% respectively).
- Almost all of the participants were eight or nine years old (98%).
- More than half of the learners were English second-language speakers (56%) with 53% having isiXhosa as their first language.
- Twenty four (5%) of the learners were repeating the grade.
- Only a small number of learners wore prescription lenses (7%) or had identified attention deficit issues (8%).
4. VISUAL PERCEPTUAL ASPECTS TESTS (VPAT)

The visual perceptual aspects pre- and post-test results (see Folder 1 of the attached CD) were saved into an Excel Spreadsheet and then sent to the Nelson Mandela Metropolitan University's Statistical Services. The data generated from the sample of 443 learners were normally distributed which enabled parametric analyses to be undertaken such as t-tests and analysis of variance (ANOVA). Non-parametric measures were made of the distribution of scores within the schools using $\chi^2$ to reveal distributions of factors such as achievement, gender, age, language, etc. Descriptive and inferential statistics are presented below in light of the objectives of this study.

T-tests were used to analyse whether groups were statistically different from each other before and after the implementation phase. A t-test is appropriate for comparing the means of two groups. Differences between the two groups with a probability value (p) of less than or equal to 0.05 ($P \leq 0.05$) indicates that there is a statistically significant difference in the result at a 95% level of confidence. A probability value of 0.01 ($P \leq 0.01$) indicates that there is a 99% level of confidence that the difference between the two groups are statistically significant and not due to chance. A probability value of $p > 0.05$ indicates that the difference between the two groups can be attributed to chance (Gravetter & Walnau, 2008).

Cohen’s d statistics were calculated to measure the magnitude of effect size. According to Gravetter and Walnau (2008) effect size as expressed by Cohen’s d statistics is defined as the difference in mean divided by the pooled standard deviation and is a measure of magnitude/significance of the differences between the pre- and post-tests/questionnaires scores. A small practical significance is noted where $0.2 < d < 0.5$; a moderate practical significance is noted where $0.5 < d < 0.8$; and a large practical difference is recorded if $d > 0.8$. In other words:
an effect size of less than 0.2 is considered to be insignificant,

an effect size between 0.2 and 0.49 is considered to be of small significance,

an effect size between 0.5 and 0.79 is considered as moderately significant, while

an effect size of 0.8 or more is considered to be highly significant.

4.1 Overall results from the five participating schools

The results obtained from the Visual Perceptual Aspects Test (VPAT) pre- and post-tests (nine subtests) of the five participating schools were analysed and are presented in the following sequence:

- the combined test results in terms of learner achievement from the participating schools per subtest for the comparison group (classes 1) and experimental group (classes 2 and 3) (Section 4.1.1),
- the test results per school per subtest for the comparison group (classes 1) and experimental group (classes 2 and 3) (Section 4.1.2),
- the combined test results in terms of learner achievement from the participating schools per section for the comparison (classes 1) and experimental group (classes 2 and 3) (Section 4.1.3),
- the test results per school per section for the comparison group (classes 1) and experimental group (classes 2 and 3) (Section 4.1.4), and
- differences in learner achievement in terms of gender, age and home language (Section 4.1.5).

As mentioned previously, each subtest is scored out of 16. Results are therefore presented, both in graphical and tabular form, out of a score of 16.
4.1.1 Test results per subtest for the comparison and experimental groups

As displayed in Table 4.7 and Figure 4.3, an improvement from pre- to post-tests occurred in seven of the nine subtests for the comparison group. However, only three of these subtest score changes are statistically significant. Visual discrimination (VD) and visual memory (VM) are statistically significant at a 99% level of confidence while visual figure-ground (VF-G) is statistically significant at a 95% level of confidence.

In contrast, Table 4.7. and Figure 4.4. show that the experimental group improved in all nine subtests. Although the change in score is small, eight of the nine subtests are statistically significant at a 99% level of confidence. The 9th subtest, visual analysis and synthesis (VA/S), is statistically significant at a 95% level of confidence. The biggest improvements occurred in three subtests, namely, visual sequential memory (VSM), visual memory (VM) and position-in-space (P-S). These were followed by visual figure-ground (VF-G), visual discrimination (VD), visual closure (VC), visual spatial-relationships (VS-R), visual form constancy (VFC) and lastly visual analysis and synthesis (VA/S). Table 4.7 depicts the inferential statistics indicating the change in score from pre- to post-test for each of the nine subtests for both the comparison and experimental groups.
Table 4.7:

*Change in mean scores for the participating schools from the pre- to post-tests for each of the nine subtests for the comparison group (classes one in each school)\((n = 146)\) and experimental group (classes two and three)\((n = 297)\)*

<table>
<thead>
<tr>
<th>Subtests</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δ(\bar{x})</td>
<td>p</td>
</tr>
<tr>
<td>Visual discrimination</td>
<td>1.25</td>
<td>0.0000**</td>
</tr>
<tr>
<td>Visual form constancy</td>
<td>-0.28</td>
<td>0.0597</td>
</tr>
<tr>
<td>Visual memory</td>
<td>0.82</td>
<td>0.0005**</td>
</tr>
<tr>
<td>Visual sequential memory</td>
<td>0.38</td>
<td>0.1733</td>
</tr>
<tr>
<td>Visual spatial-relationships</td>
<td>0.34</td>
<td>0.2925</td>
</tr>
<tr>
<td>Position-in-space</td>
<td>-0.35</td>
<td>0.2857</td>
</tr>
<tr>
<td>Visual closure</td>
<td>0.41</td>
<td>0.1031</td>
</tr>
<tr>
<td>Visual figure-ground</td>
<td>0.66</td>
<td>0.0341*</td>
</tr>
<tr>
<td>Visual analysis and synthesis</td>
<td>0.17</td>
<td>0.4663</td>
</tr>
</tbody>
</table>

* Statistically significant at a 95\% level of confidence

** Statistically significant at a 99\% level of confidence
Figure 4.3: Test results in terms of learner achievement from the participating schools per subtest for the comparison group (classes one) \((n = 146)\)
Figure 4.4: Test results in terms of learner achievement from the participating schools per subtest for the experimental groups (classes two and three) \((n = 297)\)
4.1.2 Test results per school per subtest

Table 4.8

*Change in mean scores score for School 1 from pre- to post-test for each of the nine subtests for the comparison group (class one) (n = 23) and experimental group (classes two and three) (n = 47)*

<table>
<thead>
<tr>
<th>School 1 Subtests</th>
<th>Score</th>
<th>Change</th>
<th>Comparison Group</th>
<th></th>
<th>Experimental Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual discrimination</td>
<td>1.17</td>
<td>0.0626</td>
<td>0.41</td>
<td>0.23</td>
<td>0.5616</td>
<td>0.09</td>
</tr>
<tr>
<td>Visual form constancy</td>
<td>0.26</td>
<td>0.4082</td>
<td>0.18</td>
<td>0.51</td>
<td>0.0442*</td>
<td>0.30 (S)</td>
</tr>
<tr>
<td>Visual memory</td>
<td>1.26</td>
<td>0.0727</td>
<td>0.39</td>
<td>1.28</td>
<td>0.0260*</td>
<td>0.34 (S)</td>
</tr>
<tr>
<td>Visual sequential memory</td>
<td>2.09</td>
<td>0.0054**</td>
<td>0.64 (M)</td>
<td>1.19</td>
<td>0.0149*</td>
<td>0.37 (S)</td>
</tr>
<tr>
<td>Visual spatial-relationships</td>
<td>1.65</td>
<td>0.0540</td>
<td>0.42</td>
<td>0.66</td>
<td>0.1676</td>
<td>0.20</td>
</tr>
<tr>
<td>Position-in-space</td>
<td>0.91</td>
<td>0.1683</td>
<td>0.30</td>
<td>1.47</td>
<td>0.0129*</td>
<td>0.38 (S)</td>
</tr>
<tr>
<td>Visual closure</td>
<td>1.70</td>
<td>0.0176*</td>
<td>0.54 (M)</td>
<td>0.66</td>
<td>0.1642</td>
<td>0.21</td>
</tr>
<tr>
<td>Visual figure-ground</td>
<td>0.78</td>
<td>0.3787</td>
<td>0.19</td>
<td>1.21</td>
<td>0.0203*</td>
<td>0.35 (S)</td>
</tr>
<tr>
<td>Visual analysis and synthesis</td>
<td>0.65</td>
<td>0.2688</td>
<td>0.24</td>
<td>0.15</td>
<td>0.6819</td>
<td>0.06</td>
</tr>
</tbody>
</table>
Chapter Four - Results

Table 4.9

Change in mean scores for School 2 from pre- to post-test for each of the nine subtests for the comparison group (class one) \((n = 24)\) and experimental group (classes two and three) \((n = 47)\)

<table>
<thead>
<tr>
<th>School Change</th>
<th>Subtests</th>
<th>Score</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(\Delta \bar{x})</td>
<td>(p)</td>
<td>(d)</td>
</tr>
<tr>
<td>1</td>
<td>Visual discrimination</td>
<td>2.29</td>
<td>0.0027**</td>
<td>0.69 (M)</td>
</tr>
<tr>
<td>2</td>
<td>Visual form constancy</td>
<td>-0.42</td>
<td>0.2846</td>
<td>0.22</td>
</tr>
<tr>
<td>3</td>
<td>Visual memory</td>
<td>1.33</td>
<td>0.0268*</td>
<td>0.48 (S)</td>
</tr>
<tr>
<td>4</td>
<td>Visual sequential memory</td>
<td>1.04</td>
<td>0.0984</td>
<td>0.36</td>
</tr>
<tr>
<td>5</td>
<td>Visual spatial-relationships</td>
<td>-0.33</td>
<td>0.7385</td>
<td>0.07</td>
</tr>
<tr>
<td>6</td>
<td>Position-in-space</td>
<td>-0.43</td>
<td>0.6321</td>
<td>0.10</td>
</tr>
<tr>
<td>7</td>
<td>Visual closure</td>
<td>1.30</td>
<td>0.5625</td>
<td>0.49 (S)</td>
</tr>
<tr>
<td>8</td>
<td>Visual figure-ground</td>
<td>0.50</td>
<td>0.5292</td>
<td>0.13</td>
</tr>
<tr>
<td>9</td>
<td>Visual analysis and synthesis</td>
<td>1.17</td>
<td>0.0196*</td>
<td>0.51 (M)</td>
</tr>
</tbody>
</table>
Table 4.10

*Change in mean scores for School 3 from pre- to post-test for each of the nine subtests for the comparison group (class one) (n=29) and experimental group (classes two and three) (n=59)*

<table>
<thead>
<tr>
<th>School 3 Change</th>
<th>Subtests</th>
<th>Score</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Δx</td>
<td>p</td>
<td>d</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Δx</td>
<td>p</td>
<td>d</td>
</tr>
<tr>
<td>1</td>
<td>Visual discrimination</td>
<td>0.48</td>
<td>0.3130</td>
<td>0.19</td>
</tr>
<tr>
<td>2</td>
<td>Visual form constancy</td>
<td>-0.52</td>
<td>0.1422</td>
<td>0.28</td>
</tr>
<tr>
<td>3</td>
<td>Visual memory</td>
<td>0.24</td>
<td>0.6600</td>
<td>0.08</td>
</tr>
<tr>
<td>4</td>
<td>Visual sequential memory</td>
<td>-0.79</td>
<td>0.1928</td>
<td>0.25</td>
</tr>
<tr>
<td>5</td>
<td>Visual spatial-relationships</td>
<td>0.28</td>
<td>0.6626</td>
<td>0.08</td>
</tr>
<tr>
<td>6</td>
<td>Position-in-space</td>
<td>-1.61</td>
<td>0.0313*</td>
<td>0.43 (S)</td>
</tr>
<tr>
<td>7</td>
<td>Visual closure</td>
<td>-0.48</td>
<td>0.3381</td>
<td>0.18</td>
</tr>
<tr>
<td>8</td>
<td>Visual figure-ground</td>
<td>0.34</td>
<td>0.6356</td>
<td>0.09</td>
</tr>
<tr>
<td>9</td>
<td>Visual analysis and synthesis</td>
<td>-0.21</td>
<td>0.6282</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Table 4.11

Change in mean scores for School 4 from pre- to post-test for each of the nine subtests for the comparison group (class one) \((n = 39)\) and experimental group (classes two and three) \((n = 79)\)

<table>
<thead>
<tr>
<th>School 4 Subtests</th>
<th>Score Change</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ(\bar{x})</td>
<td>(p)</td>
<td>(d)</td>
<td>Δ(\bar{x})</td>
</tr>
<tr>
<td>Visual discrimination</td>
<td>1.67</td>
<td>0.0010**</td>
<td>0.57 (M)</td>
</tr>
<tr>
<td>Visual form constancy</td>
<td>-0.31</td>
<td>0.3725</td>
<td>0.14</td>
</tr>
<tr>
<td>Visual memory</td>
<td>0.90</td>
<td>0.0378*</td>
<td>0.34 (M)</td>
</tr>
<tr>
<td>Visual sequential memory</td>
<td>0.74</td>
<td>0.2223</td>
<td>0.20</td>
</tr>
<tr>
<td>Visual spatial-relationships</td>
<td>0.23</td>
<td>0.7009</td>
<td>0.06</td>
</tr>
<tr>
<td>Position-in-space</td>
<td>-0.13</td>
<td>0.8492</td>
<td>0.03</td>
</tr>
<tr>
<td>Visual closure</td>
<td>-0.26</td>
<td>0.5625</td>
<td>0.09</td>
</tr>
<tr>
<td>Visual figure-ground</td>
<td>0.85</td>
<td>0.1594</td>
<td>0.23</td>
</tr>
<tr>
<td>Visual analysis and synthesis</td>
<td>0.49</td>
<td>0.2807</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Table 4.12

*Change in mean scores for School 5 from pre- to post-test for each of the nine subtests for the comparison group (class one) (n = 31) and experimental group (classes two and three) (n = 65)*

<table>
<thead>
<tr>
<th>School 5 Subtests</th>
<th>Score Change</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>∆x̄  p  d</td>
<td>∆x̄  p  d</td>
<td></td>
</tr>
<tr>
<td>1 Visual discrimination</td>
<td>0.71 0.0938 0.31</td>
<td>0.28 0.4194 0.10</td>
<td></td>
</tr>
<tr>
<td>2 Visual form constancy</td>
<td>-0.32 0.2093 0.23</td>
<td>0.22 0.1920 0.16</td>
<td></td>
</tr>
<tr>
<td>3 Visual memory</td>
<td>0.55 0.2436 0.21</td>
<td>1.43 0.0026** 0.39 (S)</td>
<td></td>
</tr>
<tr>
<td>4 Visual sequential memory</td>
<td>-0.71 0.1782 0.25</td>
<td>2.38 0.0000** 0.63 (M)</td>
<td></td>
</tr>
<tr>
<td>5 Visual spatial-relationships</td>
<td>0.10 0.8911 0.02</td>
<td>0.48 0.2047 0.16</td>
<td></td>
</tr>
<tr>
<td>6 Position-in-space</td>
<td>-0.39 0.6048 0.09</td>
<td>1.22 0.0026** 0.39 (S)</td>
<td></td>
</tr>
<tr>
<td>7 Visual closure</td>
<td>0.45 0.4541 0.14</td>
<td>0.82 0.0259* 0.28 (S)</td>
<td></td>
</tr>
<tr>
<td>8 Visual figure-ground</td>
<td>0.77 0.2349 0.22</td>
<td>0.60 0.1426 0.18</td>
<td></td>
</tr>
<tr>
<td>9 Visual analysis and synthesis</td>
<td>-1.03 0.0626 0.35</td>
<td>0.49 0.1075 0.20</td>
<td></td>
</tr>
</tbody>
</table>

Inspection of the above tables reveal that of the five participating schools the most practically significant changes occurred in Schools 3, 4 and 5.

4.1.3 Test results per section for the comparison and experimental groups

As mentioned previously in Chapter Two (Section 3.1.1) the nine subtests have been divided into four sections, namely, (i) visual discriminatory aspects, (ii) visual memory aspects, (iii) visual spatial processing aspects, and, (iv) visual perceptual analytical aspects. The subtests which fall into each section are as follows:
Section 1 (visual discriminatory aspects): Visual Discrimination (VD) and Visual Form Constancy (VFC),

Section 2 (visual memory aspects): Visual Memory (VM) and Visual Sequential Memory (VSM),

Section 3 (visual spatial processing aspects): Visual Spatial-Relationship (VSR) and Position-in-Space (P-S), and

Section 4 (visual perceptual analytical aspects): Visual Closure (VC), Visual Figure-Ground (VF-G) and Visual Analysis and Synthesis (VA/S).

As shown in Table 4.13. and Figure 4.5, an improvement from pre- to post-test occurred in each of the four sections for the comparison group. However, only Sections 1 and 2 are statistically significant at a 99% level of confidence. The greatest improvement occurred in Section 2, namely Visual Memory (VM) and Visual Sequential Memory (VSM). In contrast, Table 4.13. and Figure 4.6. and show an improvement from pre- to post-test occurred in each of the four sections for the experimental group. Each section is statistically significant at a 99% level of confidence. The most improvement in the experimental group also occurred in Section 2 and then Sections 3, 4 and 1 respectively.
Table 4.13

Change in score for the participating schools for each of the sections for the comparison group (classes one) \( (n = 146) \) and experimental group (classes two and three) \( (n = 297) \)

<table>
<thead>
<tr>
<th>Section Score Change</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \Delta \bar{x} )</td>
<td>( p )</td>
</tr>
<tr>
<td>1 VD, VFC</td>
<td>0.49</td>
<td>0.0003**</td>
</tr>
<tr>
<td>2 VM, VSM</td>
<td>0.61</td>
<td>0.0027**</td>
</tr>
<tr>
<td>3 VSR, P-S</td>
<td>0.03</td>
<td>0.9098</td>
</tr>
<tr>
<td>4 VC, VF-G, VA/S</td>
<td>0.41</td>
<td>0.0111</td>
</tr>
</tbody>
</table>
Figure 4.5: Test results in terms of learner achievement from the participating schools per section for the comparison group (classes one) \((n = 146)\)
Figure 4.6: Test results in terms of learner achievement from the participating schools per section for experimental group (classes two and three)

(n = 297)
### 4.1.4 Test results per section per school

Table 4.14

*Change in score for School 1 from pre- to post-test for each of the sections for the comparison group (class one) (n = 23) and experimental group (classes two and three) (n = 47)*

<table>
<thead>
<tr>
<th>School 1 Section</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \Delta \bar{x} )</td>
<td>( p )</td>
</tr>
<tr>
<td>VD, VFC</td>
<td>0.72</td>
<td>0.0506</td>
</tr>
<tr>
<td>VM, VSM</td>
<td>1.67</td>
<td>0.0011**</td>
</tr>
<tr>
<td>VSR, P-S</td>
<td>1.28</td>
<td>0.0287*</td>
</tr>
<tr>
<td>VC, VF-G, VA/S</td>
<td>1.04</td>
<td>0.0108*</td>
</tr>
</tbody>
</table>

Table 4.15

*Change in score for School 2 from pre- to post-test for each of the sections for the comparison group (class one) (n = 24) and experimental group (classes two and three) (n = 47)*

<table>
<thead>
<tr>
<th>School 2 Section</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \Delta \bar{x} )</td>
<td>( p )</td>
</tr>
<tr>
<td>VD, VFC</td>
<td>0.94</td>
<td>0.0128*</td>
</tr>
<tr>
<td>VM, VSM</td>
<td>1.27</td>
<td>0.0098**</td>
</tr>
<tr>
<td>VSR, P-S</td>
<td>-0.23</td>
<td>0.7278</td>
</tr>
<tr>
<td>VC, VF-G, VA/S</td>
<td>0.97</td>
<td>0.0080**</td>
</tr>
</tbody>
</table>
Table 4.16

*Change in score for School 3 from pre- to post-test for each of the sections for the comparison group (class one) (n = 29) and experimental group (classes two and three) (n = 59)*

<table>
<thead>
<tr>
<th>School 3 Section</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δ̅x</td>
<td>p</td>
</tr>
<tr>
<td>1 VD, VFC</td>
<td>-0.02</td>
<td>0.942</td>
</tr>
<tr>
<td>2 VM, VSM</td>
<td>-0.28</td>
<td>0.5086</td>
</tr>
<tr>
<td>3 VSR, P-S</td>
<td>-0.60</td>
<td>0.1474</td>
</tr>
<tr>
<td>4 VC, VF-G, VA/S</td>
<td>-0.12</td>
<td>0.7310</td>
</tr>
</tbody>
</table>

Table 4.17

*Change in score for School 4 from pre- to post-test for each of the sections for the comparison group (class one) (n = 39) and experimental group (classes two and three) (n = 79)*

<table>
<thead>
<tr>
<th>School 4 Section</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δ̅x</td>
<td>p</td>
</tr>
<tr>
<td>1 VD, VFC</td>
<td>0.68</td>
<td>0.0273*</td>
</tr>
<tr>
<td>2 VM, VSM</td>
<td>0.78</td>
<td>0.0698*</td>
</tr>
<tr>
<td>3 VSR, P-S</td>
<td>0.05</td>
<td>0.9254</td>
</tr>
<tr>
<td>4 VC, VF-G, VA/S</td>
<td>0.36</td>
<td>0.2316</td>
</tr>
</tbody>
</table>
Table 4.18

Change in score for School 5 from pre- to post-test for each of the sections for the comparison group (class one) \((n = 31)\) and experimental group (classes two and three) \((n = 65)\)

<table>
<thead>
<tr>
<th>School 5 Section</th>
<th>Comparison Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\Delta \bar{x})</td>
<td>(p)</td>
</tr>
<tr>
<td>1 VD, VFC</td>
<td>0.19</td>
<td>0.3851</td>
</tr>
<tr>
<td>2 VM, VSM</td>
<td>-0.08</td>
<td>0.8467</td>
</tr>
<tr>
<td>3 VSR, P-S</td>
<td>-0.15</td>
<td>0.7702</td>
</tr>
<tr>
<td>4 VC, VF-G, VA/S</td>
<td>0.06</td>
<td>0.8726</td>
</tr>
</tbody>
</table>

Inspection of the above tables reveal that of the five participating schools the most practically significant changes in the experimental groups occurred in Schools 3, 4 and 5. Four schools, namely, Schools 1, 3, 4 and 5 improved in Section 2 at a 99% level of confidence. Discussion on these changes, both in the experimental groups and when they occurred in the comparison groups, will be discussed in chapter 5.

4.1.5 Differences in terms of gender, age, home language, whether this was their first or second time in Grade 2, whether they wear prescription lenses or not and their medical background

Chi-square tests were run on each of these aspects. However, no statistically significant differences were indicated for any of these aspects, namely, gender, age, home language, whether this was their first or second time in Grade 2, whether they wear prescription lenses or not and whether they are ADD, ADHD, ADD and medicated, ADHD and medicated (see Folder 1 of the attached CD).
Summary of the quantitative VPAT results

- There was a statistically significant improvement in all of the pooled VPAT subtests in the experimental group scores and statistically significant improvement in three of the comparison group VPAT subtest scores.
- Eight of the nine subtest improvement scores in the experimental group were at the 99% level of confidence, while the 9th subtest (visual analysis and synthesis) improvement was at the 95% level of confidence.
- The largest changes in mean scores were in the visual sequential memory (VSM), visual memory (VM) and position-in-space (P-S) subtests.
- All of the effect sizes for the pooled data were small.
- Disaggregation of the data into schools and subtests showed that the most practically significant effects (medium effect sizes) occurred in Schools 3, 4 and 5.
- Improvement from pre- to post-test occurred in each of the four sections for the experimental group at the 99% level of confidence.
- The greatest improvement in the experimental group occurred in Section 2 with a medium effect size, and then with small effect sizes in Sections 3, 4 and 1 respectively.
- Four schools, namely, Schools 1, 3, 4 and 5 improved in Section 2 at a 99% level of confidence.
- No statistically significant differences were indicated for, gender, age, home language, whether this was their first or second time in Grade 2, whether they wear prescription lenses or not and whether they are ADD, ADHD, ADD and medicated, ADHD and medicated.
Chapter Four - Results

5. QUALITATIVE RESULTS: VISUAL PERCEPTION

As mentioned earlier, qualitative data were gathered using three instruments, teacher record sheets, observations and teacher interview protocols. In order to maintain confidentiality, the ten teachers from the five participating schools who were part of the intervention aspects of the study were assigned a code. The code consisted of the letter T which meant teacher, followed by the letter S with their school number (S1, S2, S3, S4 or S5), followed, after a colon, by the letter C and numbers 2 or 3. The numbers 2 and 3 referred to the classes they taught. For example, TS1: C2 refers to the teacher from School 1 who taught class 2, TS2: C3 refers to the teacher from School 2 who taught class 3 and henceforth.

5.1. Teacher record sheets

As requested, teachers completed a new sheet after each activity on which they recorded the date, the activity’s name, the number of bricks used for that particular activity, whether learners understood the activity, whether learners were able to complete the activity, whether learners enjoyed the activity, and any comments or observations they wished to note (Appendix C).

The record sheets revealed that the teachers completed between 25-45 activities with their respective classes. Teachers indicated that most of the activities were understood and completed by almost all of the learners in their classes. They did note that there were times when a few learners did not grasp what was expected of them so they (the teachers) repeated the activity. Each of the teachers noted that the learners had fun and enjoyed most of the activities.

The teachers made few general comments and focused more on visual-spatial vocabulary, visual memory and patterning. Some comments were made regarding the visual...
challenges learners encountered while other teachers wrote what caught their attention while the learners were doing the various activities. Certain activities required learners to describe their bricks or the towers, patterns and models they built. Teachers were surprised at the spatial vocabulary their isiXhosa first language learners used. Vocabulary included words such as left, right, more, less, bigger, smaller, upside down, half and other words. Some comments recorded were:

*I am very excited about the language my children are using to describe their brick.*

*Children are using excellent spatial vocabulary e.g. more, less, bigger, smaller, taller, shorter. They are also learning their left from their right (TS5: C2)*

*Learners using the word ‘half’ in their vocabulary and realised that the number of studs had to be even (TS1: C3)*

*Spatial vocab again was awesome - left, right, more than, less than, least, most, upside-down, turn onto long side, turn onto short side (TS5: C3)*

Certain activities required learners to form a design and pattern with their ‘6 Bricks’ while other activities required them to continue a pattern which the teacher began. The teachers were surprised at their learners’ creativity. Some comments recorded were:

*The pupils came up with so many lovely designs, pictures and patterns (TS3:C2)*

*Some really wonderful patterns created (TS5: C3)*

*Very enjoyable especially when they could see how the pattern could keep on repeating (TS5: C3)*

Certain activities required the teachers to build a model, show it to the learners for a few seconds and then ask them to replicate the model. The teachers mentioned that in the beginning their learners did not pay too much attention, but as the activities progressed they
became more involved. The children began repeating the colour sequence to themselves from either top-to-bottom or bottom-to-top to help them remember the sequence. The teachers also pointed out that learners were able to remember the sequence and position of up to 4 bricks but found 5-6 bricks challenging. Some comments recorded were:

*Great to see learners using their memory, many children kept more attention than usual, children loved it (TS5: C2)*

*Most learners remembered the sequence of the bricks (up to 4 bricks) by saying the colours over and over to themselves – bottom to top (TS5:C2)*

*By the third example I could see an improvement in memory because they started to concentrate more (TS4: C3)*

*Learners struggled to remember the sequence of 5-6 bricks, some selected the incorrect colours and many errors with the positioning of the bricks (TS3: C2)*

*We play this memory game often, whenever we have 5 minutes to spare. Learners love it and I can see how they are getting better (TS5: C3)*

*What a fun activity but quite challenging, I spent time asking questions like how they remembered the model, they gave many different ideas, it was great (TS2: C2)*

*They remembered the colour sequence the ‘6 Bricks’ came in and together as a class we restacked the bricks every day the same way (TS5: C3)*

Some activities required the learners to work in pairs. One partner built a model with 3 bricks while the other blind-folded partner felt the model and was then required to replicate the model. In this activity, colour did not matter but rather the position of the bricks. Some comments recorded were:
Excellent tactile and memory exercise (TS2: C2)

Good listening, children used their sense of touch to remember the sequence to build (TS5: C2)

Teachers mentioned some of the visual challenges their learners encountered during the activities. Some comments recorded were:

A few students confused the top and bottom of the page and built upside down (TS3:C2)

I should not move the model around, changing the orientation confuses the learners (TS5: C2)

Some learners were not facing the board ‘head-on’ which affected their perception (TS1:C3)

I had to get some learners to explain to their partners how to sort according to position, we did many examples of this and practiced until everyone could sort on their own and then in their pairs (TS3: C3)

Some learners got confused with the starting side and also whether the pattern was vertical or horizontal. I found this interesting. They did however get better with every example (TS5: C3)

Teachers mentioned some of the interesting observations which caught their attention during the activities. Some comments recorded were:

Learners realised that what they perceive when they look from a distance is very different to when I bring the brick arrangement (model) to them (TS1: C3)

Was interesting to watch how learners work with their right and left hands (TS5: C3)
Kids loved looking at which colour group had the most bricks, which group had the same, which group had the tallest tower, which group had the shortest tower (TS5: C3)

Great to see the different strategies used for counting the bricks and studs, some groups counted in 2’s and others counted in 1’s. They were also good at double-checking each other’s answers (TS5: C3)

Very interesting to watch how learners loved trying even when they could not do it. They were very motivated and determined to get it right (TS5: C3)

5.2. Researcher’s observations on visual perception

Three classroom observation visits were made to each of the ten teachers of the experimental group (classes 2 and 3). I played the role of observer-as-participant sitting at the back of the classroom, writing descriptive and reflective notes pertaining to visual perception (Appendix E). Teachers chose the days that best suited them for me to visit their schools. I did not intend to observe specific activities with every class but coincidentally landed up observing the same activities with most of the classes which are categorised according to activity below. A brief synopsis of four activities is presented. I found a number of commonalities between the teachers and learners of the five schools which are discussed below in my descriptive and reflective notes.

Memory Game

This activity requires the teacher to take any three bricks and secretly click each brick together in a different spatial position. The teacher then holds the arrangement up for the learners to see for five seconds before hiding it away. The learners build the arrangement from memory and once done hold it up for the teacher to see.
Initially some learners did not grasp what the activity required of them but by the second or third example they were on par with the rest of the class. All eyes were on the teacher, focusing intently on the arrangement she was about to show them. Once the model was shown to them, I could hear them mumbling to themselves. The teacher instructed them to build the arrangement and it was interesting to see the speed at which they selected the bricks, continued mumbling to themselves and built the arrangement. Listening intently, I realised they were repeating the colour sequence from either top-to-bottom or bottom-to-top to themselves. Most learners were able to successfully build the arrangement, while a few learners selected the correct colours but had the incorrect spatial position. After a few examples, the teacher began asking questions which required learners to reveal the methods they used to help them remember the arrangement shown to them. They mentioned the following:

“*I saw the red at the bottom, blue in the middle and orange on the top*”

“*I saw the warm and cold colours*”

“*I remembered the order*”

“*I kept on saying the colours to myself*”

“*I remembered the colours from the top to the middle to the bottom*”

“*I remembered the colours from bottom to the top*”

“*I saw how many studs were covered*”

I realised that the classroom seating of the learners played a key role. The learners who had the incorrect spatial position were not facing the teacher head-on but had a side-view instead, and were therefore unable to see exactly how many studs were covered or left uncovered in the teacher’s arrangement. Some of them were also seated towards the back of the classroom which limited their viewing of what the teacher was presenting.
Chapter Four - Results

**Patterning**

This activity requires the teacher to build the start of a repeating pattern for learners to follow. Learners are then instructed to copy and extend the pattern. The teacher repeats this a few times, creating different pattern combinations; both horizontally and vertically, by adding spaces between the bricks or packing the bricks tightly together. Teachers then discussed the patterns with their learners, asking them to describe a pattern and also to identify patterns in the classroom or everyday life.

Most learners were able to copy and extend the teacher’s patterns. Some learners were only concerned with copying the pattern and colours whereas others paid attention to detail, ensuring that the spaces between their bricks were almost as narrow or wide as the teachers. The horizontal patterns posed to be slightly more challenging than the vertical patterns for the learners. Upon reflection, I realised that when the teachers stood in front of the class and faced their learners, the teachers’ right side was the learners left side which was the main reason most of the learners had their horizontal patterns the other way around (reversed).

Some teachers indicated to learners the difference between a horizontal and vertical pattern. It was amazing how quickly they learnt the words and understood the difference and were able to visualise what they were told. Thereafter, each time a pattern was built they called out ‘horizontal’ or ‘vertical.’

A class discussion followed with teachers asking their learners to describe and find a pattern in the classroom or everyday life. Many learners identified patterns which the teachers admitted they had not taken note of before. When asked to describe a pattern, these were some of their responses:

“A pattern is a zig-zag”

“A pattern can be a wave”
“Sometimes shapes make a pattern”

Kim’s Game

Kim’s Game activity requires the teacher to arrange 3 bricks on an A4 piece of paper. The children study the arrangement for 30 seconds after which the teacher covers the arrangement. The teacher then instructs the learners to recall and copy her arrangement. The teacher repeats this activity using 3 bricks a few times. Once the learners are confidently and successfully remembering the arrangement of 3 bricks, the teacher progresses to 4 or more bricks.

The teachers used their black or white boards for this activity. All eyes were on the board, focusing intently on the arrangement before the teacher covered it. Once the teacher instructed them to build the arrangement, it was interesting to see the speed at which they selected the 3 bricks and placed them on their page. Initially some learners did not grasp what the activity required of them but by the second or third example they were on par with the rest of the class. Most learners were able to successfully build the arrangement. A few learners selected the correct colours but had the incorrect arrangement while others had the correct arrangement but one or two incorrect colours. I saw these learners improve as the teacher repeated the activity.

Another key observation was the orientation of the A4 page. Some teachers laid their page on the board in the portrait style but their learners had their pages in front of them in the landscape style. This affected the way they arranged their bricks. Teachers were quick to spot this and ensured that the learners’ page matched theirs on the board. It was also interesting to see how learners corrected their arrangement once the teacher uncovered hers and how they helped each other to ensure that everybody at their table had the correct arrangement. They were eager and could not wait for the teacher to build another arrangement.
Measuring Objects

This activity requires learners to work in groups of 4-6 to measure the length, width and height of their desks and chairs. Learners stack their bricks horizontally when measuring the length and width but vertically when measuring the height. Learners count the number of bricks and studs and record their results on a worksheet provided. The teacher then compares the learners’ results and discusses which (length, width or height) is the tallest or shortest. Teachers could repeat this activity using different objects in the classroom.

All the groups were able to complete this activity. Some groups were more particular than others, ensuring that their bricks were placed on the edge of the desk. Some groups were concerned with creating a colourful pattern as they stacked their bricks. Some groups had little spaces between their bricks while other groups wanted their bricks tightly stacked together.

It was fascinating to watch how the different groups counted the studs, counting in 1’s, 2’s or 3’s placing their little fingers on the studs as they counted. At times they lost count and had to begin all over again. Some groups recounted just to make sure they had the correct answers.

It was interesting to hear the mathematical vocabulary learners were using during the class discussions with the teachers. Vocabulary such as halves and quarters, even and odd were used to explain how their group came to their answers. Some responses were:

“We counted 10 and a half bricks”

“Our group measured five and a quarter bricks”

The more precise groups challenged those groups that rounded their answers off to a whole number. The classroom discussion continued until consensus was reached between the groups and the teacher.
5.3. Teachers’ perceptions regarding visual perception

As mentioned earlier, semi-structured, open-ended interviews were conducted with the ten teachers of the experimental group (classes 2 and 3). The interview questions were categorised into themes, one of them being the effect that ‘6 Bricks’ had on the development of learners’ visual perception (Appendix G). The interviews were transcribed and then coded according to the Tesch method.

The interviews required the teachers to provide the following demographical details as shown in Table 4.19:

- How many years have you been teaching foundation phase?
- How many years have you been teaching Grade 2?
- Have you used Duplo Bricks in your teaching before?

Table: 4.19

Teachers’ demographical details (n = 10)

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Years teaching foundation phase</th>
<th>Years teaching Grade 2</th>
<th>Duplo Bricks in teaching before</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS1: C2</td>
<td>21</td>
<td>19</td>
<td>Never</td>
</tr>
<tr>
<td>TS2: C2</td>
<td>32</td>
<td>19</td>
<td>Never</td>
</tr>
<tr>
<td>TS3: C2</td>
<td>31</td>
<td>15</td>
<td>Never</td>
</tr>
<tr>
<td>TS4: C2</td>
<td>15</td>
<td>12</td>
<td>Never</td>
</tr>
<tr>
<td>TS5: C2</td>
<td>16</td>
<td>14</td>
<td>Never</td>
</tr>
<tr>
<td>TS1: C3</td>
<td>6</td>
<td>6</td>
<td>Never</td>
</tr>
<tr>
<td>TS2: C3</td>
<td>10</td>
<td>10</td>
<td>Never</td>
</tr>
<tr>
<td>TS3: C3</td>
<td>26</td>
<td>21</td>
<td>Never</td>
</tr>
<tr>
<td>TS4: C3</td>
<td>20</td>
<td>19</td>
<td>Never</td>
</tr>
<tr>
<td>TS5: C3</td>
<td>11</td>
<td>11</td>
<td>Never</td>
</tr>
</tbody>
</table>

As illustrated in Table 4.19, the teaching experience at foundation phase varied between 6-32 years while the teaching experience of Grade 2 varied between 6-21 years. None of the
teachers used Duplo Bricks in their teaching prior to the intervention. However, most teachers had Lego Blocks in their classrooms which their learners played with during free play.

As noted before, the Visual Perceptual Aspects Test is made up of nine subtests, namely:

- visual discrimination – what is similar or different in form (e.g. the formation of letters and numbers, shapes),
- visual form constancy – recognising a form whether presented in a different way, colour (e.g. a capital letter and a lower case letter, words like bad and bed),
- visual memory – (to remember what was visual seen e.g. spelling, copying from the board, multiplication),
- visual sequential memory (counting in 2’s or 3’s),
- visual spatial-relationships – the directionality (e.g. was and saw, spacing when writing),
- position-in-space – matching to forms in the directionality,
- visual closure
- visual figure-ground, and
- visual analysis and synthesis

The following three questions were posed to each of the teachers.

1) Which visual perceptual aspect do you think improved the most through ‘6 Bricks’?
2) Which visual perceptual aspect do you think improved the least through ‘6 Bricks’?
3) Do you think the visual perceptual aspects transferred to other activities in the classroom?
Regarding the visual perceptual aspect which improved the most, teachers’ responses varied and many of them chose more than one subtest. Some teachers responded immediately, some responded hesitantly while others acknowledged that they did not know and were keen to see the quantitative results. Almost all of the teachers who did respond chose visual memory. Some responses were:

“Memory, I would say” (TS3: C2)

“I’d say the memory then the discrimination and then the spatial-relationships” (TS3: C3)

“I would say visual memory and spatial-relationships and position-in-space. Sequential memory as well” (TS4: C3)

“I would like to say that it’s the sequential memory, this one, I would think because I did a lot of that, putting things in a sequence, building it up, putting it back together, I would like to think that that’s the one because we worked a lot on that one” (TS5: C3)

“Visual memory, I think” (TS1: C2)

“Yoh, I’d lie if I say” (TS2: C3)

“... Can you not pick this up from the... Yoh, that’s very difficult” (TS2: C3)

“Position-in-space ... I don’t know, I don’t know” (TS5: C2)

Regarding the visual perceptual aspect which improved the least, teachers’ responses once again varied and many of them chose more than one subtest. Some teachers responded immediately, some responded hesitantly while others acknowledged that they did not know. The teachers who did respond chose figure-ground. Some responses were:

“Form constancy” (TS4: C2)
“The closure maybe, or the figure-ground” (TS4: C3)

“Maybe the figure-ground, I don’t know if that would have improved, it’s hard to say because they are also developing naturally” (TS1: C3)

“I don’t know, I don’t know” (TS5: C2)

With the exception of one teacher who thought it very difficult to measure, the teachers felt that although they did not have a test by which they could answer with certainty, the visual perceptual aspects transferred across into the classroom in some way or another. Some teachers felt that learners improved in their assessments or copying from the board, some felt that being able to visualise during the activities assisted their learners to transfer these acquired skills and concentrate more on other school-related tasks, and some felt that it helped certain learners more than others. Some responses were:

“It’s difficult to measure, you know..?” (TS1: C2)

“We don’t have a test to say yay or nay, but I’d like to think that it did” (TS3: C3)

“Well definitely, I mean their pattern making and when they did patterns with Unifix Blocks and in their formal assessment task at the end of the year when they had to, you know you had like 3 circles 2 squares, 4 circles 2 squares, they had to work out 5 circles 2 squares, those things improved which would definitely have come from the LEGO” (TS3: C3)

“...phonics when they wrote those tests, they do remember those words and you can see it in their marks” (TS4: C2)
“Copying from the blackboard, definitely” (TS4: C3)

“Because they could picture what they had done, yes, most definitely. So visualisation helps them definitely, it keeps them more involved, it helped with their keeping their concentration” (TS5: C2)

“I would definitely say it helped some children, specially towards the end of the year when you have those border line cases that you thought half way through the year I don’t know if they going to make it and they actually did. Now, it could just be their maturity but it could have been this too” (TS3: C2)

“Yes, yes it did. Some more than others but I definitely think that there were some improvements with the other children” (TS5: C3)

“Hugely, hugely, without a doubt, I definitely think so, that’s why I would like to see the results because I think you going to see a big improvement” (TS2: C2)

Summary of the qualitative data on the visual perception aspects of the study

- Teachers’ teaching experience at Foundation Phase varied between 6-32 years, while the teaching experience of Grade 2 varied between 6-21 years.
- Three classroom observation visits were made to each of the ten teachers of the experimental group (classes 2 and 3).
- Teachers completed between 25-45 activities with their classes, respectively.
- Teachers found it interesting to see the motivation and determination of their learners while playing with the ‘6 Bricks’.
- Learners’ visual perception was affected if they did not face the board ‘head-on’.
- Orientation and spatial positioning of the bricks posed challenging for some learners.
isiXhosa first language learners were heard using spatial vocabulary.

Learners’ attention span and creativity improved as the activities progressed.

Memory activities with the ‘6 Bricks’ got the learners to think about the methods they use to remember (meta-cognition).

Mathematical vocabulary such as halves, quarters, even and odd were used during mathematical activities with the ‘6 Bricks’.

Teachers thought that learners’ visual discrimination, visual memory, visual sequential memory, visual spatial-relationships, and position-in-space improved the most by playing with the ‘6 Bricks’.

Teachers thought that learners’ visual form constancy, visual figure-ground, and visual closure improved the least.

Teachers felt that the visual perceptual aspects gained by playing with the ‘6 Bricks’ transferred into the classroom (learners improved in their assessments, copying from the board, and concentration).

6. **THE RAVEN’S COLOURED PROGRESSIVE MATRICES (RCPM) TESTS**

   All five primary schools participated in the second part of this study, i.e. ‘6 Bricks with exploratory talk’. As mentioned earlier, the only difference in terms of participants was that 436 learners took part in the Raven’s Coloured Progressive Matrices (RCPM) quantitative data collection instead of the 443 who wrote the Visual Perceptual Aspects Tests (VPAT). The reason for this decrease in number (from 443 to 436) was because these seven learners were absent on the days set aside for the pre- and post-testing. Again, teacher record sheets, researcher observation schedules and five semi-structured teacher interviews (class 3 teachers) provided qualitative data. The biographical information generated was the same as the Visual Perceptual Aspects Test data which was completed for each learner before testing began.
The RCPM pre- and post-test (see Folder 2 of the attached CD) results were saved into an Excel Spreadsheet and then analysed with the assistance of the Nelson Mandela Metropolitan University’s Statistical Services. Descriptive and inferential statistics are presented and discussed below.

6.1 Overall results from the five participating schools

The results obtained from the Raven’s Coloured Progressive Matrices (RCPM) pre- and post-tests of the five participating schools were analysed. The results are presented in the following sequence:

- the combined test results in terms of learner achievement from the participating schools for the comparison group (classes 1 & 2) and experimental group (class 3) (Section 7.1.1),
- the test results from the participating schools for the groups separately (class 1, class 2 and class 3) (Section 7.1.2),
- the test results per school for the comparison group (classes 1 & 2) and experimental group (class 3) (Section 7.1.3), and
- differences in learner achievement in terms of gender, age and home language (Section 7.1.4).

Raven’s Coloured Progressive Matrices is scored out of 36. Results are therefore presented, both in graphical and tabular form, out of a score of 36.

6.1.1 Test results for the comparison and experimental groups

As noted earlier, the comparison groups for the Raven’s Coloured Progressive Matrices were classes 1 and 2, whereas the experimental group was class 3 from each of the five participating schools.
As displayed in Table 4.20 and Figure 4.7, an improvement from pre- to post-tests occurred for both the comparison and experimental groups. Table 4.20 depicts the inferential statistics indicating the change in score from pre- to post-test for both the comparison and experimental groups.

Table 4.20

*Change in RCPM mean scores for the participating schools from the pre- to post-tests for the comparison group (classes one and two) (n = 289) and experimental group (class three) (n = 147)*

<table>
<thead>
<tr>
<th>Raven’s Score Change</th>
<th>Pre-Test to Post-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δx</td>
</tr>
<tr>
<td>Comparison Group</td>
<td>3.28</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>2.65</td>
</tr>
</tbody>
</table>

** Statistically significant at a 99% level of confidence

Figure 4.7: RCPM test results in terms of learner achievement from the participating schools from pre- to post-tests for the comparison (classes one and two) (n = 289) and experimental group (class three) (n = 147)
6.1.2 Test results for classes one, two and three separately

As displayed in Table 4.21 and Figure 4.8, an improvement from pre- to post-tests occurred in each of the three classes. Although the results are statistically significant at a 99% level of confidence, the greatest improvement occurred in class two.

Table 4.20 depicts the inferential statistics indicating the change in score from pre- to post-test for the three classes.

Table 4.21

Change in RCPM mean scores for the participating schools from the pre- to post-tests for class one (n = 141), class two (n = 148) and class three (n = 147) separately

<table>
<thead>
<tr>
<th>Raven’s Score Change</th>
<th>Pre-Test to Post-Test</th>
<th>Δ(\bar{x})</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes 1</td>
<td>3.26</td>
<td>0.0000**</td>
<td>0.65 (M)</td>
<td></td>
</tr>
<tr>
<td>Classes 2</td>
<td>3.31</td>
<td>0.0000**</td>
<td>0.87 (L)</td>
<td></td>
</tr>
<tr>
<td>Classes 3</td>
<td>2.65</td>
<td>0.0000**</td>
<td>0.53 (M)</td>
<td></td>
</tr>
</tbody>
</table>

** Statistically significant at a 99% level of confidence
Figure 4.8: Test results in terms of learner achievement from the participating schools from pre- to post-tests for class one \((n = 141)\), class two \((n = 148)\) and class three \((n = 147)\) separately

6.1.3 Test results per school for classes two and three

Table 4.22 depicts the inferential statistics indicating the change in score from pre- to post-test for classes two and three. Inspection of the table reveals that a greater improvement occurred in class two compared to class three of Schools 1, 2 and 4. However, class 3 improved more than class 2 in Schools 3 and 5.
Table 4.22

*Change in RCPM mean scores for the participating schools from pre- to post-test for classes two and three*

<table>
<thead>
<tr>
<th>Raven’s Score Change</th>
<th>Class 2</th>
<th>Class 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δ(\bar{x})</td>
<td>p</td>
</tr>
<tr>
<td>School 1</td>
<td>1.52</td>
<td>0.0474*</td>
</tr>
<tr>
<td>School 2</td>
<td>5.27</td>
<td>0.0000**</td>
</tr>
<tr>
<td>School 3</td>
<td>3.70</td>
<td>0.0000**</td>
</tr>
<tr>
<td>School 4</td>
<td>3.95</td>
<td>0.0000**</td>
</tr>
<tr>
<td>School 5</td>
<td>1.91</td>
<td>0.0039*</td>
</tr>
</tbody>
</table>

6.1.4 Differences in terms of gender, age, home language, whether this was their first or second time in Grade 2, whether they wear prescription lenses or not and and their medical background

Chi-square tests were run on each of these aspects. However, no statistically significant differences were indicated for any of these aspects, namely, gender, age, home language, whether this was their first or second time in Grade 2, whether they wear prescription lenses or not and whether they are ADD, ADHD, ADD and medicated, ADHD and medicated (see Folder 2 of the attached CD).

Summary of quantitative data for the Raven’s Coloured Progressive Matrices Test

- Analysis of the comparison and experimental pooled data (all experimental groups versus all comparison groups) showed statistically significant improvements in the mean scores of both of the two groupings with medium effect sizes.
Disaggregation of the data into classes across the five schools showed that the RCPM mean scores of classes 2 (experimental group where the children played with the ‘6 Bricks’ but had no exploratory talk) improved statistically significantly with a large effect size.

Classes 1 (no intervention) and classes 3 (intervention which included exploratory talk) across the five schools showed statistically significant RCPM mean score improvements with medium effect sizes.

Analysis of the changes in RCPM mean test scores showed that classes 2 (play but no exploratory talk facilitation by teachers group) in Schools 2, 3 and 4 showed statistically significant improvements at the 99% level of confidence with large effect sizes.

Analysis of the changes in RCPM mean test scores showed that classes 3 (play with exploratory talk facilitation by teachers group) in Schools 2, 3 and 5 showed statistically significant improvements at the 99% level of confidence with medium (Schools 2 and 5) and large (School 3) effect sizes.

No statistically significant differences in RCPM scores were indicated between gender, age, home language, whether this was their first or second time in Grade 2, whether they wore prescription lenses or not, or whether the children are ADD, ADHD, ADD and medicated, ADHD and medicated or not.

7. QUALITATIVE RESULTS: EXPLORATORY TALK

As mentioned earlier, qualitative data were gathered using three instruments, teacher record sheets, researcher observations and teacher interview protocols. In order to maintain confidentiality, the five teachers from the five participating schools were assigned the same code as mentioned in Section 5 of this chapter. The code consisted of the letter T which meant teacher, followed by the letter S with their school number (S1, S2, S3, S4 or S5), followed,
after a colon, by the letter C and number 3. The number 3 referred to the class they taught. For example, TS1: C3 refers to the teacher from School 1 who taught class 3, TS2: C3 refers to the teacher from School 2 who taught class 3 and henceforth.

7.1. **Teacher record sheets**

As requested, teachers completed a new sheet after each activity on which they recorded the date, the activity’s name, whether the groups of learners were able to adhere to the exploratory talk ground rules or not and any comments or observations they wished to note (Appendix D).

The teachers were requested to complete ten activities for ‘6 Bricks with exploratory talk’. The record sheets revealed that TS2 and TS4 completed 6 activities, TS1 completed 7 activities, while TS3 and TS5 were the only teachers to complete the 10 activities. Teachers’ indicated that this was due to time constraints. The learners also required more than the allocated time and they could not afford to take time out of their school schedules. They also mentioned that instead of completing the ‘6 Bricks with exploratory talk’ activities on a weekly basis as I requested, they waited for the end of term, when all assessments were complete and they and their learners had more time.

Considering the above explains why teachers noted very little to no comments or observations on their record sheets. Their comments focused on the seven rules, the challenges groups encountered while trying to complete the activities and the reasons why they thought groups were able or unable to adhere to the rules.

Most teachers mentioned that when they introduced exploratory talk, there was a lot of arguing and fighting with very little discussion within the groups for the first few activities. Some mentioned that this continued throughout with learners unable to adhere to the rules. Some comments recorded were:
Lots of arguing within certain groups (TS3: C3)

Some groups fought (TS5: C3)

Not too much discussion taking place (TS2: C3)

Some groups had no communication at all (TS5: C3)

Some teachers pointed out that learners did not always listen to the instructions which meant that it took them a while to understand what was expected of them. Some comments recorded were:

Listening skills are not always great (TS5: C3)

Groups took a while to grasp and follow the instructions (TS3: C3)

Most of the teachers noted that the stronger personalities within the groups dominated while other learners just sat back accepting the first idea without challenging or offering an alternative idea. Some learners also got more involved than others. Some comments recorded were:

Struggled to get started, lots of strong personalities (TS1: C3)

Some learners don’t allow everyone to have a turn (TS5: C3)

Learners just seem to accept what others say without giving an alternative idea, they just seem to agree with one another (TS2: C3)

Some groups are still learning to challenge each other’s ideas (TS5: C3)

Some got more involved than others (TS5: C3)

However, some teachers pointed out that towards the end, some groups were working well together and getting better at implementing the rules. They were even having fun and came up with some creative ideas. Some comments recorded were:
Other groups worked so well together (TS3: C3)

Some groups are getting better (TS5: C3)

What fun to build bridges (TS5: C3)

Loved this activity, the groups came up with great ideas for their creatures (TS3: C3)

Importantly, TS4 found that there was partial to no following of rules in her class which consisted of 39 learners working in groups of 5-6 learners. TS2 stated that she battled to assess most of the seven rules with her class. She felt that they were too young and struggled to express themselves in English. She also found that the groups did not think for themselves but rather copied whatever the first group built.

7.2. Researcher’s observations on exploratory talk

Three classroom observation visits were made to each of the five teachers of the experimental group (class 3). Teachers chose the days that best suited them for me to visit their schools and I played the role of observer-as-participant. As mentioned earlier, the purpose of the observations was to derive data relating to exploratory talk by observing learners in their groups which included, their adherence to the exploratory talk ground rules, their ability to discuss and share ideas and engage in exploratory talk, their level of exploratory talk and lastly their ability to complete the activity (Appendix F). A three point scale evaluating seven criteria were used during the observations. Table 4.23. to 4.29. illustrates the five teachers observed as TS1, TS2, TS3, TS4 and TS5 and how they rated against the criterion being measured.

Criterion 1: Teacher’s explanation of activity

The first area of observation was on the explanation given by the teachers when instructing learners regarding the ‘6 Bricks with exploratory talk’ activities. This was to determine if the instructions given by the teachers were clear and easily understandable.
Table 4.23

Teacher’s explanation of activity

<table>
<thead>
<tr>
<th>Teacher</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS1</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>TS2</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>TS3</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>TS4</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>TS5</td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

Teachers’ explanations of the activities were clear and easily understandable. Instructions were given more than once in different ways with teachers posing questions thereby determining whether learners had grasped what the activity required of them or not. Learners were also permitted to seek clarity by posing questions to the teachers before they were instructed to begin the activity. There were times when learners called their teacher to their group just to ensure they were on the right track.

Criterion 2: Teacher recaps exploratory talk ground rules

The second area of observation was to determine whether teachers recapped all, some or none of the exploratory talk ground rules with their learners. This was important as exploratory talk was being introduced for the first time to these learners and the rules were all new to them.
Table 4.24

*Teacher recaps rules*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Criterion 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TS1</td>
<td>None of the rules</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>TS2</td>
<td>Some of the rules</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>TS3</td>
<td>All of the rules</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>TS4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS5</td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Prior to instructing their learners to proceed with the activity, each teacher requested their learners to look at the poster with the exploratory talk ground rules hung in their classrooms (Appendix B). They recapped each rule with their learners, and even produced examples of things that went ‘completely right’ or ‘horribly wrong’ in previous activities so learners could get a better understanding of the rules. It appeared as though most learners understood the rules but some had difficulty implementing them within their groups. Some teachers had to reiterate the rules during the activity.

*Criterion 3: Learners’ adherence to rules*

The third area of observation was to determine whether learners could adhere to all, some or none of the exploratory talk ground rules.
Table 4.25

*Learners’ adherence to rules*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Criterion 3</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS1</td>
<td>No rules adhered to</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS2</td>
<td>Some rules adhered to</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS3</td>
<td>All rules adhered to</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>TS4</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Every class adhered to the rules but the degree of adherence for each class varied. TS1, TS3 and TS5 learners adhered to most of the rules. A certain amount of arguing, fighting, dominance, stubbornness and non-participation was noted within some of the groups which prevented them from adhering to all the rules. Although I have said that TS2 and TS4 learners adhered to some of the rules, this was based on the groups that I observed who were trying very hard to engage in exploratory talk. Language, however, appeared to be a huge barrier for these learners and they seemed to find it difficult to think and express themselves.

**Criterion 4: Learners working in groups**

The fourth area of observation was to determine learners’ interaction within the groups. Teachers allocated learners to groups, who they explained, were not grouped academically but had mixed abilities within each group. Groups consisted of 4-6 learners.
Table 4.26

*Learners working in groups*

<table>
<thead>
<tr>
<th>Criterion 4</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>No interaction</td>
<td>Limited interaction</td>
<td>Extensive interaction</td>
</tr>
<tr>
<td>TS1</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>TS2</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS3</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>TS4</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS5</td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

TS1, TS3 and TS5 learners were actively engaged but the degree of engagement within the groups differed. Although I have indicated that there was extensive interaction, this was based on the majority of the groups I observed. As mentioned earlier there were a few groups where arguing, fighting, dominance and non-participation occurred. However, it was exciting to watch and listen to the way they shared ideas, demonstrated to each other if they thought their model would break or fall down and decide on the best and second-best ideas. TS2 and TS4 learners required continuous motivation from the teachers who walked from group to group re-explaining and guiding. A few of the groups were then able to get started and some managed to complete the activity. A great amount of competitiveness was evident within TS1, TS3 and TS5 classes with groups competing against each other building creative models by incorporating pattern and colour.

*Criterion 5: Learners’ participation in exploratory talk*

The fifth area of observation was to determine the extent to which learners participated in exploratory talk.
Table 4.27

Learners’ participation in exploratory talk

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Criterion 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Teacher</td>
<td></td>
</tr>
<tr>
<td>TS1</td>
<td></td>
</tr>
<tr>
<td>TS2</td>
<td></td>
</tr>
<tr>
<td>TS3</td>
<td></td>
</tr>
<tr>
<td>TS4</td>
<td></td>
</tr>
<tr>
<td>TS5</td>
<td></td>
</tr>
</tbody>
</table>

As mentioned above, there was enough evidence that TS1, TS3 and TS5 learners engaged in exploratory talk in their groups. They could be heard using words such as ‘I think’, ‘because’, ‘what if’, ‘but’, ‘shouldn’t we’, ‘let’s try’ and ‘let’s first see’ which are words used during exploratory talk. TS2 and TS4 teachers did most of the talking but a few learners from the groups who managed to work within their groups could be heard using some of the above mentioned words.

Criterion 6: Learners’ level of exploratory talk

The sixth area of observation was to determine the level on which learners engaged in exploratory talk which was either deep, surface or none.
Table 4.28

Learners’ level of exploratory talk

<table>
<thead>
<tr>
<th>Criterion 6</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>None</td>
<td>Surface</td>
<td>Deep</td>
</tr>
<tr>
<td>TS1</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS2</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS3</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS4</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS5</td>
<td>√</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Although I have indicated that the level for every class was surface, this varied. TS1, TS3 and TS5 learners’ level was surface while TS2 and TS4 learners were just touching the surface. Once again, I could not indicate none as there were a few learners within these classes who tried to express themselves despite English being their second language.

Criterion 7: Learners’ completion of activity

The final area of observation was to determine whether learners were able to complete, partially complete or were unable to complete the observed exploratory talk activity.

Table 4.29

Learners’ completion of activity

<table>
<thead>
<tr>
<th>Criterion 7</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>Not completed</td>
<td>Partially completed</td>
<td>Completed</td>
</tr>
<tr>
<td>TS1</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>TS2</td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>TS3</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>TS4</td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>TS5</td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
TS1, TS3 and TS5 learners were able to successfully complete the activities. A few groups in TS2 and TS4 managed to complete the activities with guidance from their teachers while other groups copied each other.

Apart from the above criterion, there were some interesting observations I noted. Certain activities required learners to build models of bridges, towers or vegetable patches. Teachers were creative and innovative and instead of just instructing the learners to build the model, would narrate a story where the learners had to imagine themselves as a group of engineers or farmers who were tasked with building these models. After narrating the story, learners were instructed to close their eyes and imagine how they would build their model and what their model would look like. A few minutes later, learners were asked to share their ideas within their groups. Their eagerness to share their ideas was visible on their faces and could be heard in the excitement in their voices.

Teachers thought of ways to maintain comparison and discipline within the groups so that every learner was given a fair chance to express his/her idea. It was also an indirect technique used to encourage learners to adhere to most of the rules. TS1 in particular, handed a tennis ball to every group which was passed along and held by each learner while they expressed their idea. This strategy worked well in most groups but not in groups where strong personalities dominated or where others just sat back.

Listening closely, I could hear learners reminding one another within their groups to adhere to the rules. Some groups agreed to what they thought was the best idea and the second-best idea, built their first model, showed it to their teacher and then attempted the second-best idea within the allocated time.

There was a great amount of competitiveness within the classes among the groups with learners vying to create the most creative model. Teachers displayed the various models at the
end of the activity which led to a class discussion with groups explaining why they had built their model in a certain way.

What was encouraging was that I saw an improvement in the learners of TS2 and TS4. Initially they were noisy, unsettled and hasty to get started without having fully understood the teachers’ instructions. However, their ability to listen to the teacher, listen to their group members, share and participate gradually improved and they began to grasp what was expected of them.

7.3. Teachers’ perceptions regarding exploratory talk

Semi-structured, open-ended interviews pertaining to exploratory talk (Appendix H) were conducted with the five teachers of the experimental group (class 3). Their biographical details can be found in Table 4.19. under Section 5.3. Once again the interviews were transcribed and then coded according to the Tesch method. TS1, TS3 and TS5 had similar answers for most of the questions while many commonalities were found in TS2 and TS4 answers. The following questions were posed to each of the teachers:

1) Do you believe that exploratory talk actually happened in your classroom?
2) Do you believe that the children actively engaged in exploratory talk?
3) If so, at what level were they engaged in exploratory talk? Deep, surface, none?
4) Did you talk less and the children more when you facilitated exploratory talk in your class?
5) Were the children able to adhere to the rules? Which rule did they comply with the most? Which rule did they comply with the least?
6) Were they able to successfully complete the activities?
7) What is your opinion regarding exploratory talk?
8) Will you continue with it in the future?

The three teachers, TS1, TS3 and TS5, believed that exploratory talk took place in their classrooms. They affirmed that in the beginning it was hard for most of their learners to explain and share ideas but it got better over time. The activities required their learners not only to think, but to think out of the box. They mentioned that being able to visualise as they built played an important part in their learners’ reasoning. TS2 AND TS4 affirmed that they struggled with their learners who did not grasp the rules, could not think for themselves, and could not express themselves because of the language barrier. Teachers explained:

“I think they very young so it’s very hard for them to do umm... to share their ideas, they, they shy, they... even the ones that are confident, I mean... they just like... It’s hard for them to explain why so the whole like... you know... giving a reason” (TS1: C3)

“I struggled with that I must be honest with you, because... I really struggled. I dunno is it because of our... the type of child we have. They don’t grasp, they don’t get those pointers you have there, to think different. I battled with it, yah” (TS4: C3)

“I think also because of a language problem and also because they can’t think for themselves. They haven’t been taught up until this stage of their lives to actually think for themselves. There’s a lot of copying. There’s a lot of I can’t do it, I’ll just do what the next person does” (TS2: C3)

TS1 and TS3 felt that the level of exploratory talk for their learners was surface. TS5 differed, she felt that the level for many of her learners was deep but surface for others. The three teachers mentioned that their learners shared ideas within their groups, demonstrating to one another whether they thought their model would work or not. TS5 said that she would swop the groups so different ideas would emerge. TS2 and TS4 felt that their learners were just
scratching the surface. They chose not to say ‘none’ as they felt that there were a few learners who tried.

“Probably surface, I was hoping for deep” (TS3: C3)

“Surface, the real scratching the surface” (TS4: C3)

The three teachers agreed that some learners engaged more than others with the outspoken and stronger personalities dominating while the quieter, shy learners took a back seat. Some learners would put their idea forward to their group but insisted that their idea be chosen. Other learners would not put forward their idea if they thought that the group would not accept their idea. TS2 mentioned that there is a language barrier which meant that only a few learners engaged. TS4 stated that her learners were loud and noisy and there was a lot of talking within their groups but she could not say if it was exploratory talk.

“Not all of them, definitely not all of them. The one that cried and performed for most of the time, she had stopped her crying and performing by the end but she battled to say what she wanted to say. And the little boy he was also as stubborn as all get out, umm, he was only prepared to talk if everybody was going to listen to him and only him” (TS3: C3)

“Only some of them. And again it’s a language barrier thing so I think for them to express themselves is very difficult... So I must be honest, in some of the activities that we had to do I had to like, almost like draw it out of them cos they couldn’t do it on their own” (TS2: C3)

The three teachers, TS1, TS3 and TS5, admitted that in the beginning they did a lot of talking but spoke less as the activities progressed. TS2 confessed that she talks too much and perhaps did not give her learners enough of a chance. TS4 admitted that she had to intervene and repeat herself a lot.
“Not in the beginning, no... because I had to speak a lot. But it got better where they had to talk, where I would just explain and then they would carry on” (TS5: C3)

The three teachers, TS1, TS3 and TS5, agreed that their learners were able to adhere to most of the rules but needed reminding before and during every activity. TS2 noted that her learners battled to adhere to the rules while TS4 said that her learners hardly ever adhered to them.

“Those rules... I had to remind them every single lesson and very often during the activity” (TS3:C3)

“No, not always, hardly ever” (TS4:C3)

Table 4.30

*Teachers’ responses regarding which rule learners were able to comply with the most and the least*

The table below shows that teachers’ responses varied regarding the rule which learners were able to comply with the most and the least. Some teachers chose more than one answer.

<table>
<thead>
<tr>
<th>Exploratory Talk Rules</th>
<th>Adhered to the most</th>
<th>Adhered to the least</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TS1</td>
<td>TS2</td>
</tr>
<tr>
<td>1 Everyone must think about what they have been asked to do</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Everyone must say what they think</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3 It’s ok to think differently</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>4 Remember to be polite</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5 Listen carefully to the others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Agree with the best answer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TS2 explained that it is common for her learners to copy what the other learners say and therefore would not express themselves even if they thought differently. She mentioned:

“... it’s the same thing at news time, we sit on a Monday morning I go to Spur. I promise you everyone in my class went to Spur. So, that’s just them. They can’t express themselves” (TS2: C3)

TS1, TS3 and TS5 chose rules 2 and 6 explaining that some of their learners sat back while others took over.

“I did find that some of them would bulldoze others so it wouldn’t really be a consensus. So a quieter child wouldn’t really add, give anything there” (TS5: C3)

TS4 said that her learners hardly ever adhered to rules so it was difficult for her to choose a specific rule. She explained that rules 2, 3, 4 and 5 were very difficult for her learners to grasp.

The three teachers, TS1, TS3 and TS5, felt that their learners were able to complete the activities which they managed to get to. TS2 and TS4 felt that only a few learners were able to. TS2 explained again that her learners do not think for themselves but rely on others.

“Well they all landed up doing what had to be done. So when they had to build a bridge they all managed to build a bridge, and if the thing fell in they started again and came up with a better idea.... In all of the activities they managed to get to what I would presume the end product was supposed to be” (TS3: C3)

“They weren’t really all thinking for themselves, they were relying on the next person... And I just found that with the little ones, maybe with higher up children something like that would work... And that happens all the time in the classroom. They sit back and rely on the next person to talk. Even when you doing counting on the carpet, like that,
it’s the same ones that will always answer. You’ll have others that have either switched off or they can’t be bothered to think for themselves” (TS2: C3)

Teachers’ opinions regarding exploratory talk differed. TS1 said that it is excellent and advised that teachers should do it more often. She felt that because it is time-consuming, teachers spoon-feed learners by just giving them the answers instead of letting them discover on their own. It made her realise that she did not always have to tell her learners how to solve something. She mentioned that after introducing exploratory talk, if there was conflict among her learners, she would ask them what they were going to do about it and they would come up with a solution. TS3 admitted that she preferred the ‘6 Bricks’ activities to the ‘6 Bricks with exploratory talk’ activities. She reasoned that the ‘6 Bricks’ activities required every learner to participate whereas some learners dominated or just sat back during the ‘6 Bricks with exploratory talk’ activities. This required her to constantly try to get all the learners to participate. TS5 said that it definitely challenged and got her learners to think. However, to find the time was very difficult for her because she did not limit her learners to five or fifteen minutes but wanted them to complete the activity.

TS2 said that it is important at Foundation Phase because children need to be trained to think for themselves, to discuss with others, to work with peers and to solve a problem. She wondered if it would have been better if her learners did exploratory talk in their home language. TS4 disclosed that she likes the idea and all the values that it instils. She thinks it a brilliant concept especially in a smaller environment. She thought of reasons why her learners struggled and mentioned that perhaps they were too young to grasp the idea or the class size was too big (39 learners).

All the teachers stated that they would continue with exploratory talk in the future. TS1 thinks a good idea to do after assessment when her learners can have fun and try out new things.
TS3 said that she will repeat the activities but change the groups to see what learners come up with a second time. TS5 thought of a way that it might work in her class and said that she would try it in the extra lesson after school when there are less learners for her to manage. But she did question the language issue.

**Summary of the qualitative data on the exploratory talk aspects of the study**

- Three classroom observation visits were made to the five teachers of the experimental group (class 3).
- Teachers completed between 6 and 10 of the ‘6 Bricks with exploratory talk’ activities.
- The biggest obstacle was time constraints, with learners requiring more than the allocated time to complete the activities.
- Instructions given by the teachers were clear and easily understandable.
- Teachers recapped the ground rules before each activity.
- Degrees of engagement within the groups differed, with language appearing to be a barrier for isiXhosa learners.
- Competitiveness and creativity were evident among groups with most groups able to successfully complete the activities.
- Learners used exploratory words such as ‘I think’, ‘because’, ‘what if’, ‘but’, ‘shouldn’t we’, ‘let’s try’ and ‘let’s first see’ in their talk.
- Learners’ level of exploratory talk varied between surface and just touching the surface.
- Arguing, fighting, dominance, stubbornness and non-participation prevented groups from adhering to all the rules. Gradually this improved as learners began to grasp what was expected of them.
TS1, TS3 and TS5 were of the opinion that exploratory talk took place in their classrooms, and as time progressed groups worked well together, implemented the rules, had fun and came up with creative ideas.

TS2 and TS4 differed, saying that there was partial to no following of rules, and thought that their learners were too young at times to engage in exploratory talk.

Opinions regarding exploratory talk differed. TS1 and TS4 thought it to be an excellent idea, TS3 preferred the ‘6 Bricks’ activities, reasoning that every learner was required to participate, TS5 thought it challenged her learners to think, and TS2 said it is important to begin at Foundation Phase.

The teacher stated that they would like to continue with exploratory talk in the future.

8. TEACHERS’ PERCEPTIONS REGARDING THE ‘6 BRICKS’ APPROACH

One-on-one, semi-structured, open-ended interviews were held with the ten teachers from the five participating schools who formed part of the ‘6 Bricks’ intervention. The purpose of these interviews was to gain rich and in-depth data with regard to their understandings and beliefs regarding the ‘6 Bricks’ approach (Appendix I). The teachers were once again assigned the same code as mentioned earlier (Section 5 of this chapter). Their biographical details can be found in Table 4.19. under Section 5.3. Once again the interviews were transcribed and then coded according to the Tesch method. The questions were categorised into themes with the findings presented below.

Eight of the ten teachers have sets of small LEGO blocks in their classrooms which learners can play with during their free play time. All the teachers admitted that prior to the ‘6 Bricks’ intervention, none of them used DUPLO or LEGO in their teaching. During this study the teachers were requested to complete three activities per week. Only three teachers, namely TS3:C2, TS3:C3 and TS5:C3, managed to complete three or more activities of between 10-45
minutes per week over the course of the intervention. The rest of the teachers (seven) mentioned that either time or other school-related issues prevented them from completing the three activities per week during certain weeks.

The teachers mentioned that their learners reminded them to do the ‘6 Bricks’ activities, with some pointing out that their learners reminded them on a daily basis. TS4:C2 thought her learners reminded her because “it was something different for them instead of just work, work, work.” Every teacher confessed that they, together with their learners, enjoyed the activities. Some of their responses were:

“Mine, couldn’t wait for it, everyday they’d ask me” (TS2:C2)

“They always enjoyed it. It was always different, never monotonous” (TS4: C3)

“Definitely, although some more than others. There were some they loved, they just didn’t want to stop” (TS1: C2)

Teachers were asked whether the children remained excited by the ‘6 Bricks’ activities throughout the intervention or if they become bored or distracted. Every teacher responded that the learners loved the activities and could not wait to play. Other teachers reasoned that the activities were so varied that they looked forward and loved it each time they played.

“They loved it and asked me daily when we were going to be playing bricks. I couldn’t have a day without someone ask me. It wouldn’t just be one child, it would be a couple throughout the day and they were very disappointed if we didn’t do it” (TS5: C3)

“And there was no assessment or anything so it was just fun. And no one could do anything wrong which was great. They could just build it up and look at each other and play, that was really nice” (TS2: C2)
The teachers agreed that because the learners looked forward to playing with the bricks, the majority remained focused and engaged throughout the activities. Some added that their learners, who generally cannot focus for long periods, sometimes got distracted and lost focus after playing for some time, but that they expected that this would happen. In addition, the teachers mentioned that they found it easy for them to monitor their learners because all were involved in the same activity at the same time. Teachers explained:

“While they were doing the activities they were extremely focused, they were. I didn’t ever have to say ‘come and sit at your desk and do this,’ they were extremely focused. They were really focused during that time” (TS4: C2)

“The majority of them were involved throughout the activity. It’s just your usual suspects that would lose focus” (TS5:C2)

“Normally in class you’ve explained and then this lot go off and do this thing and that lot go off and do that thing and you can’t keep your eye on what everyone’s doing. Because this was the set rule and the whole class had to do this at the same time, you could see what everyone was doing. So the whole class had to listen at exactly the same time and you had to look and see what everyone was doing at exactly the same time” (TS3: C3)

Regarding the period of time that learners were able to concentrate, teachers’ responses varied. Some estimated 10-15 minutes, some stated the duration of the activity, some said it depended on the level of difficulty while others said it depended on the time of the day.

“I think the 20 minutes was probably pushing it too far, 15 would probably be a better ask. Well obviously the shorter activities they are going to focus better because
obviously the longer the thing takes to do you are going to lose some of the children along the way side. But in general, majority of them were focused, definitely” (TS3:C3)

“And I suppose depending on the degree of difficulty of the activity, they could lose interest if they were struggling, you know... and couldn’t do it” (TS3:C2)

“It depended on the time of the day that I did the activity. It depended umm... say for example after break, it would take a little bit longer for them to concentrate because they were running outside. If I did it first thing in the morning I found they were at their best and it would last for a longer period of time. Obviously the end of the day was more challenging” (TS5:C3)

The teachers pointed out that initially learners grabbed, fiddled and began playing and building with the ‘6 Bricks’ before the instructions were given. However, as time progressed, the learners showed more discipline, self-regulation and inhibitory control.

“As we went on there were definitely changes. In the beginning they just wanted to play but as we went on they would wait for my instruction. So it did change, all of them, they all changed. The beginning was harder, as they got more use to it they started to listen. Because it all actually goes down to listening, listening to the instruction to be able to do the activity. So as soon as their listening improved, the activity would go quicker, it would be easier for them so they would know what to do, they wouldn’t get confused. So it was a time thing, as it went” (TS5:C3)

Most of the teachers said that they did not use the ‘6 Bricks’ during their teaching to help learners grasp new ideas. They did however mention referring to certain activities learners had completed with the ‘6 Bricks’ which they thought would assist them to gain a better understanding of things such as mathematical concepts like measurement and multiplication.
“You know when we measured the perimeter umm... and then soon after that we did like a frame. I wanted them to do a frame and I said something about... Remember how we did the ‘6 Bricks’ and how we put the bricks on the outside, that’s what it’s got to look like, so we referred to it” (TS2:C2)

According to the teachers, by playing with the ‘6 Bricks’ learners learnt social skills, listening skills, communication skills, to remember instructions, to take turns, to share ideas, to work in a group, to come up with a plan, to solve problems and to look at things more analytically. Their views differed regarding what learners enjoyed the most about ‘6 Bricks’. Some stated the bright colours, some pointed out the fact that learners had something tactile to hold in their hands, some noted the ability to just build and put things together, some said being involved in the activity instead of listening, some mentioned competitiveness and accomplishment, some specified the challenge to get it right while others referred to having fun and enjoyment.

“Definitely the colours, I mean if they were all blue that would have been so boring” (TS1:C3)

“They loved everything about it. I think the fact that they could just play with, and touch and the tactile. A tactile thing instead of just having a pencil in their hand. They just enjoyed that tactile” (TS2:C2)

“I think just building, putting the things together. Because even sometimes when you were talking they were already starting to put the things together” (TS3:C3)

”Being actually involved instead of listening all the time, actually being involved in the lesson that was going on” (TS5:C2)
“The competitiveness” (TS4:C2)

“I’d love to say the challenge of trying to get it right. Some of them the challenge of trying to get it right was a huge thing for them and for them to work in a group where they realised that they weren’t the only one doing it and they had to work together. That was a huge thing. I could see it and specifically because my groups weren’t academically split, so you’ve got a stronger academic with a lower achieving academic. And to see how they all helped, like if a stronger one helped a not so strong one that was encouraging to see that and then eventually that one that was struggling would get it. You know they would get it themselves. That for me was a real big thing to see and I saw it quite a lot with different kids at different times with different activities, obviously. But I definitely saw how they developed into that… into a role that others got so easily but they didn’t. They would just watch like copy… and then eventually they would get it themselves” (TS5:C3)

“The fun element” (TS1:C2)

“I loved that lesson where they had to measure the height of the table because mine were like under the table and they were building like from the bottom up but they had to get under to see where the last brick went. They didn’t measure next to the side, you know... under the table, that was lekker. That was so nice” (TS2:C2)

Apart from the ‘6 Bricks’ activities, teachers permitted their learners to play with the bricks. They found that most of the time learners would either build things or replicate an activity they had previously completed.

“I found a lot of mine when they were given that chance built something, they wanted to build” (TS3:C2)
“A lot of the things that we did they did with each other, they imitate” (TS4:C3)

Teachers acknowledged that the ‘6 Bricks’ intervention was an opportunity for them to reflect upon their teaching. Some of the facts they alluded to was; not to assume that all learners have prior knowledge regarding certain concepts, to provide more than one example during explanations, to think carefully about how you give instructions, to demonstrate rather than just dictate an instruction and the importance of having fun while learning.

“Definitely, I’d say the instructions. You have to think very carefully about how you give instructions because some of them see things differently to how we think we going to see them. So you have to change your instruction the minute you see they not getting how you expect them to get it, what you visualised they not seeing that. You have to change your instruction so they can understand it. So now like my number sense book. I will explain it in one way and if I see that a lot of them have not got it, I will think of a different way to explain it. They obviously haven’t seen it how I’ve seen it in my head” (TS3:C3)

“I think a lot of them needed visualise instructions and by looking at the bricks and following what they had to build or what they had to design, they’ve learnt to not only listen now but visually look and see what is expected of them. So I don’t know, I think maybe I show a lot more now than I did before. It’s not just giving an instruction, it’s actually showing because I realise there are some children who need that” (TS3:C2)

“Yes, look I try to make it more fun. After teaching for 11 years I think the fun does sometimes just… you got to just get it done so I think it took me back to a place where we can do this in a nice fun way. And I actually incorporated a lot more fun games and things, especially in maths to teach them new concepts. Made up new stories, if a story
was stale that I didn’t wanna use it any more cos 11 years you use the same story, kinda changed it up a bit. I really... I did. So it encouraged me to be a little more inventive and fun, ya (TS5:C3)

Every teacher mentioned time as their greatest challenge. They wanted their learners to have fun and explore but there was always so much other school-related work that had to be done that time became an issue. Nevertheless, they all mentioned that they would like to continue and do the activities with other classes.

Finally teachers were asked if they would like to add anything else. Below are some of their comments.

“I was just amazed at how much you could do with just with those six bricks, you know how much you could bring in. All the different concepts they could learn just by using those six bricks, so I was quite amazed with that” (TS1:C2)

“I just think that it’s fun and children learn mostly through fun and through play. And for me that is a lot of learning through a small amount of play time. I mean its 20 minutes, 30 minutes and they gaining a lot of knowledge just by playing with bricks in 30 minutes” (TS2:C2)

“Yes, because I can honestly tell you that the fun at school is taken away a lot by the amount that we actually have to get through. So they were learning and playing at the same time and they didn’t know that they were learning so that is an absolute joy for them. I mean to play with LEGO blocks and just 6, that’s it! And they loved it. I mean just putting it in colour order. I’d like to say thank you for the opportunity because we really did have a great time and I could see the kids developing. And I could see the kids loving it and I think that’s what it’s all about. To love something and to learn while
doing it is such a huge deal, its huge for the kids. I mean you learn while playing, for them that was just insane. And as much as yes, I was worried about time and all that kinda stuff, I wanted them to play, I wanted them to have fun and they really did” (TS5:C3)

“I would love it to, I really would love it to because the children enjoyed it thoroughly. So I would love it to be a part of my every day or at least every week thing” (TS2:C3)

“I hope that one day something like this does filter into our curriculum, something where the children are more involved” (TS5:C2)

Summary of the qualitative data on teachers perceptions of the ‘6 Bricks’ approach used in this study

- None of the teachers used LEGO in their teaching prior to this intervention.
- TS3:C2, TS3:C3 and TS5:C3, managed to complete three or more activities per week, while time or other school-related issues prevented the other teachers from doing so.
- Learners reminded the teachers to do ‘6 Bricks’ activities with them.
- Activities were varied and learners looked forward to playing.
- Teachers found it easy to monitor learners because all were involved in the same activity, at the same time.
- Initially learners fiddled with the ‘6 Bricks’ but as time progressed they developed self-discipline.
- Learners learnt many skills (social, listening, communication), and to think analytically.
- Learners enjoyed having something tactile to work with.
- Apart from the ‘6 Bricks’ activities, learners were permitted to play with the bricks at other times.
Through the ‘6 Bricks’ intervention, teachers reflected on their teaching and realised the importance of having fun while learning.

Time posed as every teacher’s greatest challenge.

Teachers were amazed at how much they could do with just six bricks.

Teachers would like ‘6 Bricks’ to be a part of their daily or weekly activities.

They are hopeful that ‘6 Bricks’ will become part of the curriculum.

9. CHAPTER SUMMARY

In this chapter the quantitative and qualitative data generated in this study are presented in order to answer the principal research question *Does construction play in the forms of guided play and guided play that employs exploratory talk using the ‘6 Bricks’ approach develop learners’ visual perception and reasoning abilities?* Quantitative data were generated via two instruments, namely the Visual Perceptual Aspects Test (VPAT) and the Raven’s Coloured Progressive Matrices (RCPM) test. Qualitative data were obtained from three instruments; teacher record sheets, researcher observations and open-ended teacher interviews.

Quantitative analysis of learners’ Visual Perceptual Aspects Test (VPAT) pre- and post-tests illustrated positive changes in learners’ achievement scores relating to visual perceptual aspects as a result of the implementation strategy where learners were provided with ‘6 Bricks’. Improvements in eight of the nine subtests scores were noted for the experimental group at a 99% level of confidence, while the 9th test (visual analysis and synthesis) improvement score was at a 95% level of confidence. The largest changes in mean scores were in the visual sequential memory (VSM), visual memory (VM) and position-in-space (P-S) subtests. Qualitative data revealed that teachers completed between 25-45 activities with their classes. Teachers were of the opinion that learners’ visual discrimination, visual memory, visual
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sequential memory, visual spatial-relationships, and position-in-space improved the most through the ‘6 Bricks’ intervention.

Quantitative analysis of the comparison and experimental pooled data (all experimental groups versus all comparison groups) for the Raven’s Coloured Progressive Matrices (RCPM) pre- and post-tests showed statistically significant improvements in the mean scores of both of the two groupings with medium effect sizes. Across the five schools, the RCPM mean scores of classes 2 (experimental group where the children played with the ‘6 Bricks’ but had no exploratory talk) improved statistically significantly with a large effect size, while classes 1 (no intervention) and classes 3 (intervention which included exploratory talk) across the five schools showed statistically significant RCPM mean score improvements with medium effect sizes. Observations in the ‘exploratory talk’ group classes revealed little to no evidence of exploratory talk indicators in groups TS2:C3 and TS4:C3, but there was sufficient evidence that exploratory talk had taken place between the learners in the other three classes.

The qualitative data revealed that none of the teachers had used LEGO in their teaching prior to this intervention. Three of the five teachers (TS3:C2, TS3:C3 and TS5:C3) managed to complete three or more activities per week, while time or other school-related issues prevented the other teachers from doing so. All of the teachers believed that their learners learnt many skills (social, listening, communication, thinking analytically) from participating in exploratory talk and noted that the children appeared to enjoy the tactile aspects of playing with the Duplo Bricks. They noted that their learners and looked forward to playing with the Blocks each week. The teachers also noted that being asked to reflect on their teaching while using the ‘6 Bricks’ approach made them realise the importance of having fun while learning. They made comments during the interviews after the intervention that suggest that they had come to recognise the importance of visual perception, exploratory talk and play at the Foundation
Phase level, and that facilitating play with young children using the Duplo ‘6 Bricks’ is a potentially fruitful approach at a number of affective and cognitive levels.
1. INTRODUCTION

In this chapter the results obtained are considered in terms of answering the principal research question: *Does construction play in the forms of guided play and guided play that employs exploratory talk using the ‘6 Bricks’ approach develop learners’ visual perception and reasoning abilities?* This research question is answered through three sections. Firstly, by considering the extent to which guided construction play using the ‘6 Bricks’ approach developed learners’ visual perception (resulted in improved achievement on the visual perception test), and teachers perceptions of the ‘6 Bricks’ approach and whether it had any effect on learners’ visual perception. Secondly, the extent to which guided construction play using the ‘6 Bricks with exploratory talk’ approach developed learners’ reasoning abilities (result in improved achievement), and whether teachers believe the ‘6 Bricks with exploratory talk’ approach had any effect on learners’ reasoning abilities is considered. Lastly, teachers’ understandings regarding the ‘6 Bricks’ approach and its effects are considered.

Discussion of the quantitative and qualitative data obtained and presented in Chapter Four from the data generating instruments, namely, the VPAT and RCPM tests, teacher record sheets, researcher’s observation sheets and semi-structured, open-ended teacher interviews have been integrated, compared and contrasted against the theoretical underpinnings noted in Chapter Two, where applicable. Explanations are sought in a triangulated fashion in order to give meaning and answer the principal research question. The main findings, limitations of the study, and recommendations for further research are also discussed.
2. VISUAL PERCEPTION

The Visual Perception Aspects Test (VPAT) data reveal that both the comparison and experimental groups’ overall mean scores changed from the pre- to post-tests. These findings support Rosner (1993) and Warren (1993) who maintain that visual perception continues to develop naturally, consolidate and become refined until about the ages of 11 and 12 years. However, considering that all nine of the experimental group’s subtests score changes were statistically significant as opposed to only three in the comparison group, suggests an endorsement of Vlok et al.’s (2011) as well as Yu's (2012) contentions that the development and refinement of visual perception is embedded in children’s engagement in learning activities.

In the case of this study, the children engaged in construction play that entailed the manipulating and assembling of Duplo Bricks using the ‘6 Bricks’ approach. Research findings also suggest that the development of visual perception is an active and constructive process (Cheatum & Hammond, 2000; Groffman, 2006; Wade & Swanston, 2001; Williams, 1983) whereby visual information is extracted from the environment in a selective, active and efficient way (Richman, 2006). The ‘6 Bricks’ approach required every learner to actively engage with their six different coloured LEGO bricks to complete the 5-10 minute activities. Active and purposeful engagement was promoted by providing 45 teacher guided hands-on activities designed to promote particular aspects of visual perception.

Eight of the nine subtests mean score changes in the experimental groups were statistically significant at a 99% level of confidence. Only the visual synthesis and analysis mean score improvements were at a 95% level of confidence. The greatest improvements occurred in terms of visual sequential memory, visual memory and position-in-space. However, these levels of improvement were not equitably spread over the experimental groups.
in all of the five schools, with the greatest practical significance being found in Schools 3, 4 and 5. Possible explanations for these findings will be discussed later in terms of, and framed within, the qualitative data generated.

As mentioned previously in Chapter Two (Section 3.1.1), the nine subtests fall under four sections, namely, (i) visual discriminatory aspects, (ii) visual memory aspects, (iii) visual spatial processing aspects, and, (iv) visual perceptual analytical aspects. In terms of the section groupings the comparison group mean scores improved from pre- to post-test in two sections at a 99% level of confidence, namely visual discriminatory aspects and visual memory aspects, with the visual memory aspects improving more than the visual discriminatory aspects. However, the changes were only at small levels of practical significance in both instances. In contrast, the experimental groups’ mean scores improved statistically significantly from pre- to post-test in all four sections at a 99% level of confidence. The greatest improvement occurred in the visual memory aspects section with a medium level of practical significance, followed by the visual spatial processing aspects section with a small level of practical significance. The remaining two sections, visual discriminatory aspects and visual perceptual analytical aspects also improved statistically significantly at the 99% level of confidence, but only with small levels of practical significance. Nevertheless, inspection of each of the five schools revealed that greater improvements were consistently achieved in the experimental group with the most practically significant changes occurring in Schools 3, 4 and 5, and that the largest overall improvement was found in the visual memory aspects section at four of the schools.

The quantitative findings mentioned above can be better understood when triangulated with the qualitative data generated from the teacher record sheets, interviews and classroom observations. Qualitative data with regard to the sections which yielded the greatest improvements, and which the teachers referred to most during their interviews, namely, the
visual memory, spatial processing, as well as the visual discrimination aspects, are discussed below.

2.1 Visual memory aspects

When asked in the interviews which visual aspect they thought improved the most over the intervention, the teachers’ highlighted visual memory and visual sequential memory. These responses resonate with the findings of Johns (n.d.-b) and Gathercole et al's. (2004), who explain that visual memory is one of the first visual perceptual aspects to develop, and that performance on visual memory tasks develops fairly rapidly until around the age of 11. Lightfoot et al. (2009) further explain that there is an increase in the development of memory and attention during middle childhood which is primarily due to greater efficiency in encoding, sorting and retrieving information.

Visual memory can be described as the ability to remember visual stimuli (Dednam, 2005a) and visual sequential memory can be described as the ability to remember a series of numbers, letters, forms, objects or pictures that have been presented visually and then to recall that sequence accurately (Collmer, 2016). Improvements in these aspects in this study were also revealed via the teachers’ record sheets and classroom observations of activities. When teachers built a model, showed it to their learners for a few seconds, and then asked them to replicate it, they were initially only able to replicate the teachers’ models according to exact colour, exact position and exact sequence using 2-3 bricks. However, over time and with practice, this ability extended to 4-5 bricks, with some learners even managing 6 bricks.

The greater increases in visual memory and visual sequential memory mean scores by the experimental group may also be attributed directly to block play, which Ness and Farenga (2007) maintain is a major contributor to memory development. Improvement in learners’ ability to successfully replicate the models shown to them for a few seconds can be attributed
to the use of their *visuo-spatial sketchpad*, which maintains, manipulates and processes visual and spatial information, and deals with characteristics of objects like shape and colour and is responsible for picture processing (Pickering, 2001; Schüler et al., 2011). It also signifies an increase in concentration and the ability to pay attention to detail, which is important for visual memory as visual stimuli constantly have to be analysed and memorised.

Remembering exact colour, exact sequence and exact position requires memory strategies which, according to Lightfoot et al. (2009), are acquired during middle childhood. One such strategy is rehearsal, which is the process of repeating to oneself the material that one is trying to memorise. Teachers’ wrote in their record sheets that they often heard learners repeating the colour sequence to themselves from either top-to-bottom or bottom-to-top, indicating that they were implementing this memory strategy (rehearsal).

Rehearsing as a strategy can be related to working memory, which is limited and can only store small amounts of information for short durations (de Jong, 2010). Working memory can hold no more than five to nine elements of information and actively process no more than two to four elements simultaneously. It is only able to deal with information 20-30 seconds after which all information is lost unless it is refreshed by rehearsal (van Merriënboer & Sweller, 2010). Considering that in this study the learners are at an age when their visual memory is still developing, and that remembering the colours, sequence and position of 5-6 bricks would be expected to exceed their working memory capacity, explains why most of the learners’ were usually unable to recall arrangements of more than 4-5 bricks.

Activities like copying from the blackboard or from a book require visual memory and visual sequential memory. These tasks are tedious for learners who usually cannot retain the information long enough to transfer it from the board or book and have to keep checking (Le
Roux, 2016e). One of the teachers commented that, as the intervention proceeded, she noticed that her learners were better able to copy from the blackboard.

Understanding, knowing and remembering are cognitive processes whereby information received through the senses such as vision are processed. As such, perception is an important prerequisite for cognition. The fact that the learners’ learnt to replicate models correctly over time points to them being able to hone their visual perception to help them with the cognitive process of remembering, and supports Smilansky and Shefatya's (1990) view that play contributes to advances in attention span and concentration. Loikith (1997, p. 218) notes that “visual perception is a dynamic cognitive effort that at once involves memory, strategic knowledge, short-term memory and attention to satisfy a visual task, demand or goal.”

All of the data in this study, namely, the quantitative results, the teachers’ record sheets and my classroom observations, clearly reflect greater improvements in both visual memory and visual sequential memory abilities in terms of better remembering colour, position and sequence in the experimental groups over the comparison group. This finding suggests that construction play using the ‘6 Bricks’ approach made a contribution to developing learners’ visual memory and visual sequential memory skills.

2.2 Visual spatial processing aspects

Although teachers highlighted visual memory and visual sequential memory as the visual aspect that improved the most, they reported that they believed that visual spatial-relationship and position-in-space abilities had also improved notably. Clutten (2009) and Williams (1983) note that the development of position-in-space reaches a plateau for both boys and girls at the age of nine years, and the development of visual spatial-relationship continues up to eight years for girls and 10 years for boys. The cohort of children who participated in this study fell between these ages and this fact, juxtaposed with the other data generated in this
study, suggests that the teachers’ belief that their learners’ visual spatial-relationship and position-in-space abilities had improved appears both believable and authentic.

Position-in-space can be defined as the ability to perceive an object’s position in space relative to oneself and the direction in which it is turned (e.g. up, down, in front, behind, between, left, right) (Tools to Grow, 2016c). Visual spatial-relationship can be defined as the ability to be aware of, recognise and identify the position and orientation of objects in two dimensional and three dimensional spaces (Williams, 1983). The visual spatial-relationship aspect grows out of the position-in-space aspect (Woolf, 2013). Classroom observations of activities and teachers’ record sheets revealed improvements in both aspects of this study.

Every activity with the ‘6 Bricks’, whether it related to playing, building, constructing, deconstructing, describing or remembering a model, patterning or measuring, necessitated visual spatial processing. Some activities required learners to replicate the patterns (vertical and horizontal) built by their teachers or measure the perimeter of objects, such as their desks and books. Initially they were concerned with only completing the activities, but over time and with practice, they began paying attention to detail and accuracy to the extent that if they were measuring the perimeter of their desks and books, they ensured their bricks were placed on the edge of the desks and books. When replicating their teacher’s patterns (vertical and horizontal), they ensured theirs was an exact replica, taking note of position and spaces. These observations verify Ferrara et al’s. (2011) findings who explain that while playing with blocks, children pay close attention to position, shape and space. The greater improvements in visual spatial-relationship and position-in-space mean scores by the experimental group may also be attributed directly to block play. Humphreys et al. (1993) and Shea et al. (2001) elucidate that playing and constructing with blocks allows children to play directly with spatial concepts thereby developing spatial abilities.
Visualising vertical and horizontal patterns placed on the blackboard, and then replicating them accordingly, requires a key concept of visual spatial-relationship known as laterality, which is the internal self-awareness of the left and right sides of one’s body. Developmentally, learners transmit knowledge of self (their own bodies, an egocentric localisation) onto space and objects (an objective localisation). Egocentric localisation develops gradually between the ages of six and eight (Cheatum & Hammond, 2000). Teachers wrote in their record sheets that learners were learning their left from their right and that they also found it interesting to watch how their learners worked with their right and left hands.

Research suggests that it is only at the age of ten that majority of learners are able to identify the laterality (left and right) of people facing them (Cheatum & Hammond, 2000). Observations revealed that certain teachers faced the class and built vertical and horizontal patterns on a desk, which posed challenging for some learners. The fact that in this study the learners are at an age when their perceptions of laterality of people facing them is still a developing skill, explains why some of them were unable to successfully replicate these patterns, confusing their left side with the teacher’s right side and vice-versa.

Upon closer inspection, it became apparent that most learners were able to complete activities of vertical dimension with ease but struggled with the horizontal dimension. These observations support Levine's (1991) view that children’s visual spatial concepts develop in the sequence of the vertical dimension first, followed by the horizontal dimension, with most children acquiring and mastering these dimensions by the age of eight (Clutten, 2009). Teachers wrote in their record sheets that they did not expect learners to confuse the horizontal and vertical dimensions, but also wrote that their learners got better with every activity that they did.
Research shows that while playing with blocks, children engage in spatial language (Ferrara et al., 2011) which is directly related to spatial cognition (Pruden et al., 2011). The variety of ‘6 Bricks’ activities provided a platform for learners to play directly with spatial concepts which, according to Gentner and Loewenstein (2002) and Reifel (1984) assists learners to develop and understand representations of spatial relationships between objects. These include spatial concepts such as above/below, before/after, in front of/behind, inside/outside, left/right, beside/across, on/off, high/low, near/far (Annandale, 2011; Therapy Fun Zone, 2016; Visual Learning for Life, 2016b; Woolf, 2013). In addition, Neuman and Roskos (1992) maintain that words embedded in playful contexts are learned better and faster by children. Children from low socio-economic households face contextual challenges in acquiring language, and block play is seen as a powerful educational tool in their acquisition of spatial language (Case et al., 2001; Whitehurst, 1997). Park, et al. (2008, p. 158) remark that “children of families with more limited economic resources might benefit more from their mathematics learning through block play.”

The quantitative data shows that the experimental group of Schools 2, 4 and 5 made statistically and practically significant improvements from the pre- to post-test in the position-in-space (Schools 2 and 5) and visual spatial-relationship (School 4) subtests. Considering that these schools draw learners mainly from lower-middle class working families where English is a second language, the above assertions ring true and were affirmed by the teacher interview data, particularly those from teachers of classes 2 and 3 of School 5 who expressed surprise at the development of the spatial vocabulary of their isiXhosa first language learners.

Playing with spatial toys has a significant influence on the development of spatial skills, such as deciding whether a block should go over or under another block, or whether it is aligned or perpendicular (Brosnan, 1998; Caldera et al., 1999; Ginsburg, 2007; Ness & Farenga, 2007).
One particular ‘6 Brick’ activity required learners to work in groups of 4-6 to measure the length, width and height of their desks and chairs. Learners stacked their bricks horizontally when measuring the length and width but vertically when measuring the height. Teachers were amazed at the precision with which learners stacked their bricks and the effort they took to ensure their measurements were correct which supports Ginsburg (2007), Hirsch (1996) and Pirrone et al. (2015) statements that learners become aware of depth, width, length, weight, capacity, balance, symmetry, shape, and space when playing with blocks. One teacher shared how she enjoyed watching her learners climb under their desks to measure the height of the desk (instead of measuring the side of the desk) because they wanted to see exactly where the last brick ended.

Another important observation, and something which most teachers alluded to during the interviews, was the enthusiasm with which learners compared the sizes of the towers and structures they built, competing to see whose tower was the tallest or shortest, which is something Clements and Sarama (2005) and Leeb-Lundberg (1996) acknowledge happens during block play. Deciding where to place a brick, how many studs to cover, or how high to build a tower are all related to mathematics. Teachers wrote in their record sheets that when learners were required to count the studs or number of bricks, they were often heard counting in 1’s or 2’s. They also pointed out how determined learners were to attain the correct measurements and how eager they were to double-check each other’s answers. These observations resonate with the findings of Boggan et al. (2010) and Ness and Farenga (2007), who explain that LEGO and blocks are shown to contribute to children’s arithmetic, spatial and geometric development as well as their mathematical knowledge and understanding.

Mathematical vocabulary is related to mathematical knowledge and understanding which learners used while discussing the answers to certain activities with their teachers. Teachers pointed out that their learners were often heard using vocabulary such as halves and
quarters, even and odd, which confirms Verdine et al's. (2013, p. 9) postulation that blocks “may provide an early analogue for learning explicit measurement concepts and for understanding discrete units, helping build a more concrete link between number magnitudes and number language.”

2.3 Visual discriminatory aspects

Classroom observation of activities that required learners to sort and match according to colour and position also revealed that these abilities improved over time and with practice. Learners’ ability to perceive sensory information and then discern between similarities and differences in size, shape, pattern, form, position, and colour is known as visual discrimination (Kranowitz, 2005), during which learners use recognition, matching and sorting skills (Schneck, 2001). Vlok et al. (2011) further explain that visual discrimination develops as the ability to attend to information and to memorise the information increases. Considering that the experimental groups biggest improvements occurred in the visual memory aspects section, suggests a link to the significant improvement in their visual discrimination scores.

One teacher explained that instead of her demonstrating sorting and matching according to position to struggling learners, she paired the learners and got more able children to assist their struggling partners. She reasoned that since visual discrimination required learners to pay careful attention to finer details, she thought it best to get the learners to assist each other. She explained that in this way learners who were able to sort according to position would get better as they would have to think of a way to explain to their struggling partner, but at the same time the struggling partner might benefit by listening to an explanation offered by a learner of similar age.
Other researchers, such as Le Roux (2016b) explain that visual discrimination is required to see small visual details and can be described as paying attention to detail. One of the activities required every learner to hold a brick in their hand and describe what they saw. Teachers’ wrote in their record sheets that they were amazed at their leaners ability to look at one brick so analytically and come up with so many descriptions. One teacher pointed out that her learners even noticed the fine logo ‘LEGO’ printed within each stud on top of the brick and that the rectangle at the bottom of the brick could be divided into two squares. She commented, “They really paid more attention to detail. It was really cool to see how much they could talk about one piece of plastic, so many observations” (TS1:C2).

Visual form constancy, which forms part of the visual discriminatory aspects section, although statistically significant, only yielded a mean score change of 0.33. This finding can perhaps be attributed to the fact that the bricks are of one size and there was not much one could do in terms of activities focusing on form constancy.

2.4 Visual perceptual analytical aspects

Three subtests, namely visual closure, visual figure-ground and visual analysis and synthesis, which fall under this section, showed statistically significant mean score changes, but received little attention in the teachers’ record sheets, nor were they mentioned during the interviews. A possible explanation as to why this was so is that there were only a few activities which focused on visual closure, visual figure-ground and visual analysis and synthesis.

2.5 Concluding remarks

It should be noted at this point that when the teachers were asked whether they thought the visual perceptual aspects transferred across into the classroom in some way or another, some teachers felt that learners improved in their assessments or copying from the board (as
was mentioned in the memory section); some felt that being able to visualise during the activities assisted their learners to transfer these acquired skills and concentrate more on other school-related tasks; and some felt that it helped certain learners more than others. One teacher stated specifically:

“Well definitely, I mean their pattern making and when they did patterns with Unifix Blocks and in their formal assessment task at the end of the year when they had to, you know you had like 3 circles 2 squares, 4 circles 2 squares, they had to work out 5 circles 2 squares, those things improved which would definitely have come from the LEGO” (TS3: C3)

Another teacher noted that when her learners wrote phonics tests “they do remember those words and you can see it in their marks” (TS4: C2), an achievement which requires visual discrimination, form constancy, memory, sequential memory, position-in-space, and visual spatial-relationship abilities.

All of the data above, namely the quantitative results, teacher record sheets, my classroom observations and the teacher interviews, clearly reflect greater improvements in both visual spatial-relationship and position-in-space abilities, with experimental group learners paying closer attention to position, shape and space. These findings suggest that construction play using the ‘6 Bricks’ approach contributes significantly to the development of learners’ visual spatial-relationship and position-in-space visual abilities. Previous research relating to LEGO or block play allowed children to play with LEGO or blocks of varying sizes, whereas in this study learners were only allowed to use their ‘6 Bricks’. The findings of this study using a ‘6 Bricks’ approach show that using only six bricks of the same size can contribute to the development of learners’ visual perception, with some aspects developing more than others.
and confirm Hutcheson et al's. (2014) supposition that the ‘6 Bricks’ activities can develop sensory and perceptual skills.

3. **REASONING**

The experimental groups, namely classes two and three in each of the five schools, all did the same construction play activities with the Duplo Bricks, but an additional ten activities were prescribed for classes three in each school. Teachers were provided with ten carefully selected, appropriate to their age (8-9 years), hands-on activities, designed to promote reasoning abilities through exploratory talk. These ten construction play activities were selected as they were deemed most suitable for stimulating and facilitating exploratory talk. The ten ‘6 Bricks with exploratory talk’ sessions required the learners to work in groups of 4-6 and actively engage in exploratory talk during their 15-20 minute long activities.

As a number of exploratory talk studies carried out in South African primary schools have revealed that when Grade 6 teachers were able to effectively engage their learners in exploratory talk there were statistically significant improvements in their Raven’s Standard Progressive Matrices (RSPM) scores compared to those of comparison groups (Webb, et al., 2016), there was an assumption in this study that coupling exploratory talk with construction play would produce similar results, albeit using the Raven’s Coloured Progressive Matrices (RCPM), not the RSPM. The RCPM test is very similar to the first 36 items of the RSPM, with the only difference being that they are coloured. The RCPM test is designed for children from 5 to 11 years old, while the RSPM are for children above this age into young adulthood (Raven, Court, & Raven, 1995). As such, the RCPM test was age appropriate for this study, while the RSPM was appropriate for the studies described in Webb et al. (2016).
The above assumption, however, proved not to be true. Statistical analysis of the Raven’s Coloured Progressive Matrices change in mean score data generated in this study showed statistically significant improvements at the 99% level of confidence in the mean score changes for all three groups, namely the comparison group (classes 1), the group that played with the blocks (classes 2), and the group that played with the blocks and were expected to participate in exploratory talk (classes 3). A further anomaly was that the group that played with the blocks where no exploratory talk was facilitated showed the greatest improvement in mean score with a large effect size (class 1 and 3 revealed medium effect sizes). These results do not echo the findings of previous studies where the experimental groups scored higher than the comparison groups when exploratory talk was successfully introduced to them (Rojas-Drummond & Mercer, 2003; Rojas-Drummond & Zapata, 2004; Webb et al., 2016).

Although no definite explanation for these changes in RCPM test score improvements can be ventured at this stage, factors such as maturation, history, and testing may be seen as contributing factors. Changes that occur as a result of the learners’ physiological and psychological growth is referred to as ‘maturation’, the possibility that other events in the learners’ lives might have contributed to pre- to post-test score changes is referred to ‘history’, while the possibility that learners could have scored differently on the post-test due to the practice and experience they got in the pre-test is referred to as ‘testing’ (Campbell & Stanley, 1963). Hence, ‘maturation’ in the context of the Raven’s Coloured Progressive Matrices results is a possible explanation for the increase in scores, and ‘testing’, since the test was administered in the same manner as the pre-test seem to be the case for the increased mean score changes in the comparison group. The issue of improved Raven’s scores caused by having done the test once before is acknowledged by Raven et al. (1995), as is the ‘Hawthorne Effect’ (Webb & Treagust, 2006).
Further inspection of classes 2 (experimental group where the learners played with the ‘6 Bricks’ but had no exploratory talk) and classes 3 (experimental group where the learners played with the ‘6 Bricks’ and also had ‘6 bricks with exploratory talk’) across the five schools revealed that classes 3 in Schools 3 and 5 showed greater improvements in RCPM mean scores. If the data from these two schools were the only RCPM data available, it might be argued that this result can be attributed to the fact that exploratory talk foregrounds reasoning abilities in children if they are introduced and encouraged to engage critically and constructively with each other’s ideas. However, inspection of the exploratory talk data from all of the participating schools suggest that only these teachers were able to successfully facilitate exploratory talk while the others could not. This claim is supported by the qualitative data. It is also important to note that classes 2 in Schools 1, 2 and 4 showed greater improvements in RCPM scores without exploratory talk than with it, possibly suggesting that block play lays the foundation for scientific reasoning and cognitive problem-solving (Sylva et al., 1976).

Research has shown that in order for exploratory talk to be effective and take root in classrooms, it has to be taught explicitly and practiced continually over an extended period (Mercer & Littleton, 2007), and little or no improvement in RCPM pre-post test scores could be explained by teachers being unsuccessful in terms of facilitating authentic exploratory talk and/or the duration over which it took place being too short (the qualitative presented below give credence to both speculations). However, what is puzzling is that overall the RCPM pre-post scores in group 2 (play only) improved more than was the case in group 3 (play and exploratory talk). Issues of decreased test scores after interventions which aim at increasing scores have been recorded in the literature and explained in terms of instrumentation, regression to the mean, and mortality/attrition. Firstly, changes in instrumentation or how the measuring tool is being administered or evaluated may affect the post-test score. This was not the case in this study as the pre- and post-tests were administered in exactly the same manner.
Secondly, regression to the mean should apply equally to all the groups. There was minimal mortality/attrition between pre- and post-tests. In fact, the scores did not drop in any cases, they all increased. Increases in the comparison group scores may possibly be attributed to learners becoming familiar with the test and/or the Hawthorne Effect.

While definitive explanations cannot be offered for the levels of improvement, which although statistically significant, were not equitably spread between classes 2 and 3 in all of the five schools, possible explanations for these quantitative findings may be better understood when triangulated with the qualitative data generated from the teachers record sheets, researcher observations and teacher interviews which are discussed below. What is clear is that in the cases of both classes 2 and 3, the quantitative and qualitative data generated reflected progressive changes in learners’ reasoning abilities. Play and learning expert Tina Bruce (2005) contends that play actively uses first-hand experiences; including struggle, manipulation, exploration, discovery and practice and as such, despite the fact that there is no single explanation for the gains made by both the groups, it seems more probable that the ‘6 bricks’ activities in general expanded learning opportunities and had a positive effect on the young learners who took part in this study in terms of their problem-solving and reasoning abilities.

3.1 Exploratory talk

Teachers’ record sheets revealed that only two of the five teachers, namely, TS3:C3 and TS3:C5 were able to complete the ten activities specifically chosen for ‘6 Bricks with exploratory talk’, while the remaining teachers (TS3:C1, TS3:C2 and TS3:C4) completed between 6-7 activities. Considering that improvements in learner achievement occurred in both classes 2 (comparison group where the learners played with the ‘6 Bricks’ but had no exploratory talk) and classes 3 (experimental where the learners played with the ‘6 Bricks’ and also ‘6 Bricks with exploratory talk’) within each of the five schools, supports research findings
that play contributes to advances in problem-solving strategies, reasoning, cooperation, empathy, and group participation (Linder et al., 2011; Nath & Szücs, 2014; Smilansky & Shefatya, 1990). However, this argument does not explain why overall classes 2 had greater gains than classes 3, which did the same activities plus extra ones where attempts were made to facilitate exploratory talk.

### 3.2 Facilitation of exploratory talk

Classroom observations showed that in the beginning the five teachers in classes 3 (‘6 Bricks with exploratory talk’) maintained control over the discussion process as they attempted to promote discussion within the groups. During the interviews they admitted that initially it was very difficult for them as using exploratory talk was very different to their normal way of teaching. They said, however, that as time progressed they stepped back, spoke less and assumed the role of a facilitator, encouraging and guiding learners to engage critically and constructively with each other’s ideas (Alexander, 2008; Mercer & Sams, 2006).

For learners to engage critically and constructively with each other’s ideas, requires teachers to lay down explicit ground rules, which also assisted them to maintain order within the classroom (Monaghan, 2006). The teachers realised how difficult it was for the learners to apply the ground rules of exploratory talk (Mercer & Littleton, 2007) and had to continually coach them (Dawes & Sams, 2004). However, the teachers in classes 1, 2 and 4 said that it seemed that their learners were unable to ‘buy into’ these rules. A point relating to the comments above is that one of the teachers, TS3:C4, shared that it was hard for her to maintain discipline and control due to the large number of learners in her class (39 learners working in groups of 5-6 learners), which perhaps indicates the reason for their relatively poorer changes in mean scores on the RCPM tests.
Chapter Five - Discussion, Conclusions and Recommendations

Research suggest that all learners can benefit from discussions provided they work in same ability (symmetrical) groups, since such groups will ensure an even status of power and provide more opportunities for learners to scaffold each other’s learning (Light et al., 1994). Teachers admitted that in spite of their efforts to group learners symmetrically, it did not always yield the anticipated results. There were many occasions when the voice level of the learners’ conversations increased as they tried to get their point across, they did not always listen to each other as they wanted to get their own point heard and there was in-house arguing and fighting. Some learners sat in the groups but did not communicate with each other. These observations support Alexander (2004) and Dawes and Sams (2004) view that if learners sit together it does not mean they make meaning together. The learners did not seem to be engaged in a coordinated, continuing attempt to solve a problem or, in some other way construct knowledge (Mercer & Littleton, 2007). These results resonate with the findings of Mercer and Dawes (2008) who explain that many children either do not know how to carry on a productive discussion, or do not realise that this is what they are expected to do by their teacher. In addition, results from the classroom observations indicated that majority of the learners in Schools 2 and 4 struggled to come up with their own ideas. Their teachers pointed out that ‘they have not been taught to think for themselves’ and that they copied what other learners said and built, which they described as ‘a normal occurrence’ in their classrooms.

Nevertheless, in Schools 3 and 5 and some groups in Schools 1, 2 and 4, there was evidence of gradual improvements in group work and collaboration, with learners appearing to take responsibility for their own learning (Barnes & Todd, 1977). Over time and with practice, these teachers believed that the learners within the groups might have begun to plan and think aloud with each other (Monaghan, 2004), accept the ideas of others, while also sharing, elaborating and defending their own ideas in order to reach consensus within their groups.
However, this cannot be said to have occurred with any certainty for classes 1, 2 and 4.

Some teachers in classes 3 and 5 pointed out that as learners became more confident in their ability and within their groups, they were more enthusiastic and motivated to participate in the discussions, with more and more learners within each group interacting (Pierce & Gilles, 2008). The ability to discuss, defend their ideas and think together, coupled with the variety of activities provided a platform to stimulate learners’ problem-solving skills, logical thinking and conceptual understanding, which according to researchers (Gauntlett et al., 2010; Hampton et al., 2011; Smith & Pellegrini., 2013) is something that also happens during block play.

However, exploratory talk is a social mode of thinking (Mercer, 1996), orientated towards a shared inquiry, enabling learners to explore different viewpoints and ideas within a group, and therefore requires a sufficient amount of verbalisation and language skills. Teachers from Schools 2 and 4 commented that their learners had great difficulty engaging in exploratory talk and challenging each other’s ideas due to their language barriers. They also pointed out that because their learners are isiXhosa first language speakers, it was difficult for their learners to express themselves in English. The majority of learners accepted the ideas of their group members who were academically or verbally proficient.

Overall, the data in this study, namely the quantitative results, teacher record sheets, classroom observation, and teachers’ interviews clearly reflect that the ‘6 Bricks with exploratory talk’ intervention in this study had minimal effect on classes in Schools 1, 2 and 4 in the class 3 group (‘6 Bricks’ with exploratory talk). Although these teachers attempted to promote discussion, exploratory talk as defined by Mercer (2000), was not satisfactorily achieved. In contrast, learners from Schools 3 and 5 (and a few learners from Schools 1, 2 and 4) were heard using words commonly associated with exploratory talk such as ‘why’, ‘what’,
‘but’, ‘because’, ‘I think’, ‘I agree’ and ‘let’s’ (Wegerif & Mercer, 1997). As such, what is important to note is that while the teachers’ ability to implement exploratory talk varied, the majority of the experimental group of teachers demonstrated some improvements in their practice over time, and one may thus argue that, in the context of this study, as the learners at least participated and took a stance on their ideas on occasions, one may tentatively suggest an opening of a window towards improved exploratory talk and its possible development over a more sustained period of time.

3.3 Successful exploratory talk

The qualitative findings above, namely that the teachers in Schools 3 and 5 were able to facilitate an acceptable level of exploratory talk in their classes, help explain the quantitative results which revealed greater statistically and practically significant gains in RCPM mean scores for classes 3 (play with exploratory talk) over classes 2 (play with no exploratory talk) in Schools 3 and 5 (see Chapter Four, Section 6.1.3, Table 4.22). In other words, when exploratory talk was successfully implemented there were greater gains in RCPM mean scores, as one might have expected considering the findings in the literature on exploratory talk. Another important observation, and something which most teachers alluded to during the interviews, was that at the end of the activities they would request the various groups to bring their models (towers, chairs, vegetable patches, creatures and bridges) to the front of the class and place them on a desk so that the groups could visualise each other’s designs. Teachers, particularly those from Schools 3 and 5, were surprised at the enthusiasm with which group members explained the reason why they chose to build their model in a particular way. Some groups brought in concepts of size, shape, length, weight, capacity, and balance (Pirrone et al., 2015). For the groups to have successfully completed the activities suggests that within their groups they engaged in focused, reasoned, critical discussion while they puzzled and grappled
together to come up with the best idea, thereby learning from one another (Mercer & Dawes, 2008).

3.4 Unsuccessful exploratory talk

Reasons for the teachers not being able to facilitate exploratory talk with their young learners may be attributed to the difficulties imposed by time constraints in the classroom. Interviews data revealed that the biggest challenge for the teacher was time, with activities taking much longer than expected. They noted that their learners struggled to adhere to the ground rules and needed constant reminders of what these guidelines were, and felt that if exploratory talk was introduced more gradually over a longer time their learners would become more adept at engaging in exploratory talk.

Learners cannot be expected to engage in exploratory talk without adequate guidance (Rabel & Wooldridge, 2013) and an impeding factor to the promotion of exploratory talk is insufficient training on how to encourage group discussion (Blatchford et al., 1998). Exploratory talk has to be taught explicitly to teachers, and practiced continually by learners, for it to be effective (Mercer et al., 1999; Monaghan, 2004; Sepeng, 2010; Villanueva, 2010; Webb, 2010). Observation of attempts by the teachers in this study to facilitate exploratory talk suggests that the workshop may not have provided sufficient preparation for all of the teachers. Research shows that an extended duration of exposure to any intervention is required before one can expect to see changes (Poock, Burke, Greenbowe, & Hand, 2007). Some of the teachers admitted that their learners were not afforded continuous practice as most activities were left to end of the term or once all school-related assessments had been completed. As such, a combination of possible insufficient teacher preparation for some, the young age of the learners, and language issues may have contributed to the duration of the intervention being too short to produce results in terms of exploratory talk.
An aspect of the findings which is more difficult to explain is why the classes 3 in the other three schools (Schools 1, 2 and 4), where attempts to introduce exploratory talk were unsuccessful, the gains in mean scores were less than in the classes where no attempts were made to introduce exploratory talk (classes 2). After all, both groups had covered the same activities, with classes 3 (with exploratory talk) doing additional activities where the children were expected to engage in exploratory talk. These lower gains, when combined with the two Schools (3 and 5) where greater gains were made, were of a magnitude great enough to provide an overall statistical indication that the overall class 3 grouping had made less RCPM gains than the overall class 2 grouping.

One suggestion for why this may have been the case is that the type of talk that took place was not only unproductive, but counterproductive in terms of gains in reasoning skills as compared to the groups that concentrated only on playing with the bricks. Mercer and Sams (2006, p. 510) found that the talk which takes place in primary schools when learners work together can often be “un-cooperative, off-task, inequitable and ultimately unproductive.” Research also suggests that asymmetries of talk, particularly differences in the amount of talk, predict differences in learning gains (Bianchini, 1999; Cohen, 1994) as some learners may choose to participate while others may decide not to get involved (Rajala et al., 2012). The exploratory talk activities, although concentrated at the end of the intervention by some teachers, were interspersed between the other play activities. As such, an explanatory suggestion may be that the unsuccessful attempts at introducing exploratory talk may have had disruptive and counterproductive effects in these classrooms in terms of learners’ concentration on the tasks at hand. This suggestion, while tentative and requiring further investigation, chimes with Baddeley's (1986) notion that the central executive decides what working memory pays attention to during conflicting demands. He uses the example of two activities that sometimes come into conflict, such as driving a car and talking, and points out that when
driving on a narrow road past a wobbling cyclist, it is preferable to stop talking and concentrate on driving. As the central executive directs attention and gives priority to particular activities, the unsuccessful attempts at exploratory talk may have diverted the attention necessary for developing the visual perception skills targeted by the ‘6 Bricks’ play activities.

4. TEACHERS PERCEPTIONS ABOUT THE ‘6 BRICKS’ APPROACH

When asked in the interviews whether their learners reminded them about the ‘6 Bricks’ activities, almost every teacher responded in the affirmative, saying that not a day would go by without a few learners asking them when they would play with the ‘6 Bricks’. This would continue a few times throughout the day with learners becoming very disappointed if they did not get an opportunity to play. When probed further to cite reasons why they thought the learners wanted to play with the ‘6 Bricks’, teachers mentioned that it was different to the mundane school work they do every day; it was less structured than school work; there was no assessment or pressure to get the activity right and no one could do anything wrong; it did not entail them working with a pencil in a book; but most importantly, it was fun, enjoyable, and an opportunity to play. Considering that most of these learners are between the ages of 8-9 and in the stage of middle childhood, the teachers’ views resonate with those expressed at a workshop conducted by the Centre for Science and Policy (2015) which emphasised that opportunities to play in middle childhood are equally important as they are in early childhood, and Bergen’s (2009) stance that play is the ‘medium of learning at all ages.’

Authors of the LEGO Foundation write “to play is to engage” (Gauntlett, et al., 2010, p. 9). Teachers highlighted that the engagement, focus, attention, involvement, concentration and the ability of the learners to resist distraction during the ‘6 Bricks’ activities were not seen during most other school-related tasks. Some teachers noted that not once did they have to say “come and sit at your desk and do this” because the activities were so varied and different, they
left no room for boredom and the learners played because they enjoyed it (Wardle, 1987). Teachers also thought that the activities were well-structured with explicit rules which the learners could easily understand and follow; and liked the idea that all the learners were involved in the same activity at the same time. This is not a usual occurrence in most classrooms, with only a handful of students getting the opportunity to be active for a certain period of the lesson, while the rest of the lesson mostly involves passive listening (Donald et al., 2010). One teacher specifically stated:

“Normally in class you’ve explained and then this lot go off and do this thing and that lot go off and do that thing and you can’t keep your eye on what everyone’s doing. Because this was the set rule and the whole class had to do this at the same time, you could see what everyone was doing. So the whole class had to listen at exactly the same time and you had to look and see what everyone was doing at exactly the same time”

(TS3:C3)

Another teacher compared her interactive whiteboard to the ‘6 Bricks’. She noted that the interactive whiteboard was more like watching television while the ‘6 Bricks’ was physical, involving every learner. In addition, teachers pointed out that the various ‘6 Bricks’ activities provided a platform for development and learning which supports Sutton-Smith (1997) statement that play is a serious constructive thought-provoking, and perhaps most importantly, a contemplative enterprise filled with aspects of learning, development and eventual progress. They continued to elaborate on the various activities which learners enjoyed the most, continually referring to four activities which are discussed below.

One activity required learners to first separate their ‘6 Bricks’, then hold a peg in their dominant hand and attempt to balance their ‘6 Bricks’, short end to short end, to build a tower. This activity required lots of concentration with one teacher commenting “I could see the
concentration steaming out of their eyes” (TS5:C2). In spite of the challenge and difficulty of working with a peg, learners persevered with some even requesting the teachers allow them another opportunity to attempt the activity. Teachers reasoned that it must have been the challenge or drive to succeed that drove them to attempt this activity over and over again. Two of the more senior teachers questioned how many children would have actually worked with a peg before and alluded to fine motor skills which resonates with findings by Pirrone et al. (2015, p. 153) who claim that “when children manipulate and assemble pieces, building-block play furnishes opportunities to learn and practice visual perception along with gross and fine motor skills.”

A second activity required learners to work in groups of 4-6, measuring the height of one another and then recording these on a page provided. Teachers mentioned that in spite of the fun and laughter generated by this activity, coupled with bricks falling all over, the learners were acquiring an understanding of so many mathematical concepts, such as tallest, shortest, addition, subtraction, balance, height, measurement, counting, comparing, estimating, ordering, and visualisation which supports researchers (Casey & Bobb, 2003; Ginsburg, 2007; Hirsch, 1996; Pirrone et al., 2015; Sarama & Clements, 2009; Verdine et al., 2013; Wolfgang et al., 2001) findings which happens during block play. A key point teachers noted was that in every group, each learner’s height was measured and recorded, indicating their engagement for a lengthy period of time with LEGO bricks, which according to Ness and Farenga (2007) are known as ‘countable play objects’ and have been shown to engage children for lengthy periods of time. The most enjoyable part was measuring the teacher.

Bruce (2005) contends that play lifts players to their highest levels of functioning, which involves being imaginative, creative, original and innovative. The third activity which most teachers recalled was when learners were given the freedom to design a pattern or picture
with their ‘6 Bricks’ and then trace around the bricks on a blank A4 white page. The teachers were amazed at the creativity and originality of their designs and patterns, some of which included animals, flowers, houses and guns. They also mentioned that they were surprised at the short time in which most learners were able to formulate a pattern and affirmed that play provides many opportunities to enhance innovation, flexibility, problem-solving, adaptation (Stagnitti, 2004) and creativity (Smith, 2013).

Another key observation which stemmed from the above activity were the abilities of top-achieving learners versus lower-achieving learners. Some of the top-achieving learners struggled to get certain concepts while lower-achieving learners got them the first time. Battista (1999) affirms that the teaching of mathematics in our schools tends to be an endless sequence of memorizing facts and procedures that often make little sense to students. Battista’s findings were confirmed by two teachers:

“Because Jemma in my top group, she can learn things that I’ve shown her, rote, but the minute you got to think up things yourself, she falls apart” (TS3:C3)

“I’ve discovered that, I remember my Joshua he struggled when they had to draw around the bricks, he struggled to get the line drawn around all four sides, he did the outlines and he didn’t do each individual brick and he couldn’t see it. He couldn’t see that he wasn’t doing each brick at a time, a whole rectangle, and he’s one of my top maths kids, I dunno why he just couldn’t see it. Can’t see figure-ground or something like that” (TS3:C2)

Communication Build, the activity which almost every teacher referred to, required learners to work in pairs. The teacher builds a simple model with the ‘6 Bricks’ and places it somewhere hidden from the children’s view. One child from each pair goes to the model, looks
to see how it is built, runs back to his/her partner and tells him/her (but does not help in the building) how to build the model, trying to remember all the details. The child may go back as many times as needed to look and remember details of the model. After five minutes, the pair go and compare their model to the original model and see how close they got. The teacher builds another model and the children swap roles. Teachers remarked that this single activity included a combination of visualisation, memorising, interpretation, communication, listening, and constructing. Working in pairs also required language comprehension as the one child had to interpret and understand how the other partner wanted him/her to build; impulse control as the partner who visualised the model was not allowed to assist in the building; and cooperation as the pair had to work together which is achieved through play (Smilansky & Shefatya, 1990).

This activity also required the cognitive process of using the central executive, which monitors and coordinates the phonological loop and the visuo-spatial sketchpad and then links them to long-term memory (Schüler et al., 2011).

The teachers reported that although they thought this particular activity to be fairly challenging and difficult, it was one of the activities that learners enjoyed the most which they repeated a few times. One teacher commented “What absolute fun, a little chaotic but they absolutely enjoyed it” (TS5:C3). When probed as to why they thought the learners enjoyed this particular activity, teachers cited motivation, determination, and competition as driving forces, which supports Smith's (2010) findings that play reveals flexibility, positive affect, non-literality, intrinsic motivation, and preference of performance over outcomes, as well as Ginsburg (2007) and Hurwitz (2003) views that play helps children develop new competencies that lead to enhanced confidence and the resilience they will need to face challenges in the future.

Apart from the four activities reported above and the many other activities completed during the intervention, teachers added that they permitted their learners to play with the ‘6
Bricks’ during mat-time or upon completion of their school-related tasks. They observed that during this time most learners were either seen constructing with the bricks or repeating an activity previously completed in the class. They added that there was a lot of thought going into what they were building; they were not just stacking bricks one on top of the other. Through manipulation and construction, the bricks were assembled to represent something else (Stannard et al., 2001), such as aeroplanes, machine guns, creatures, towers, houses, and bridges. Teachers elaborated that the learners would often come and show them their models, suggesting perseverance, a positive attitude towards challenge (Gauntlett et al., 2010) and a sense of accomplishment (Wardle, 2007). Play is often repeated (Burghardt, 2011) due to experience of pleasure and the absence of extrinsic goals (Smith, 2010) which were some of the reasons teachers thought other learners chose to repeat an activity instead of construct with the ‘6 Bricks’.

Another important observation, and something which most teachers alluded to during the interviews, was tactility. Picking up the bricks, turning them upside down, manipulating and assembling them, furnished the opportunities for learners to become mentally active, thereby learning to interpret and process sensory information, which included visual perception (Pirrone et al., 2015). A senior teacher commented: “I think the fact that they could just play with, and touch a tactile thing instead of just having a pencil in their hand. They just enjoyed that tactile, they loved the handling of an object” (TS2:C2). Visual perception is an active and constructive process (Cheatum & Hammond, 2000; Groffman, 2006; Wade & Swanston, 2001; Williams, 1983) whereby visual information is extracted from the visual environment in a selective, active and efficient way (Richman, 2006). Teachers explained that the combination of tactility and visualisation through the various activities with the ‘6 Bricks’ kept the learners involved which could be seen as a platform to enhance, develop and refine learners’ visual perception (Ayhan et al., 2015; Vlok et al., 2011; Wait, 2004; Yu, 2012). In addition, Kranowitz
(2005, p. 156-157) explains “when we engage in purposeful activity, our eyes become better coordinated …. The tactile sense, too, has a huge effect on vision… To see well, countless, concrete, tactile experiences really count!”

When asked what skills they thought the learners acquired and developed through the ‘6 Bricks’ approach, the teachers’ list was endless. A few of the more common skills mentioned were, social skills, listening skills, communication skills, leadership skills, organizational skills, building skills, remembering instructions, memory strategies, language, taking turns, sharing ideas, helping one another, working in a group, coming up with a plan, solving the problem at hand, experimenting, bringing out their creative side, learning from one another, waiting their turn, learning to be patient, learning to accept those that are slower than you, respect for others, inhibitory control, patience, and discipline. This endless list affirms that play contributes to the development of the physical, social, emotional, cognitive, intellectual, linguistic, and creative domains (Ferrara et al., 2011; Ginsburg, 2007; Hewes, 2007; Smith & Pellegrini., 2013; Wardle, 2007). There was not a single teacher who did not mention ‘listening to instructions’ as a skill which definitely improved over time, to the extent that one teacher stated:

“They were not allowed to begin the activity before it was their turn to start. Like, I got them to put their hands under the table and then they could only bring it out when I said it’s your turn, and sometimes I forgot to say it’s your turn. They would all be sitting there and I would ask why. Then they would say “teacher, you didn’t say it’s your turn, we can’t work” (TS1:C3)

Teachers were confident that learners would be able to carry, transfer and implement the skills they acquired through playing with the ‘6 Bricks’ to many other tasks and situations, whether school-related or not, which supports Hewes (2007) and Smith's (2013) statements
that play has an intrinsic value in childhood and is associated with immediate, short-term and long-term term benefits. Sarama and Clements (2009) believe that the benefits of playing with blocks and LEGO are far-reaching and numerous.

Despite acknowledging the value and benefit of the ‘6 Bricks’, most of the teachers were unable to complete all 45 activities selected for the intervention as proposed. Teachers felt extremely constrained by time because of the packed curriculum. They highlighted that as beneficial and valuable as the activities are, the voluminous work they are required to cover in the curriculum, assessments, paper-work, deadlines, departmental demands, extra-mural activities and other school-related responsibilities consumed most their time. Instead of considering the act of play as a primary period of activity for the child, these demands force teachers to view play as a mere afterthought or for intervals of time full of trivialities (Ness & Farenga, 2007). One of the teachers explained:

“...and nobody benefits from all the paperwork, nobody! And I think the other thing is that the ‘6 Bricks’ gives them such a change from doing all this jolly old paperwork. Worksheet, worksheet, boring old worksheet... that’s why they loved it so much because they didn’t have to actually... they played. It was a fun time for them” (TS2:C2).

These reasons and views resonate with Bergen’s (2009) and Park et al’s. (2008) findings that most schools employ drill-and-practice techniques during which educators provide young children with didactic activities such as worksheets or other academic tasks rather than provide them with opportunities to play. These paper-pencil tasks are developmentally inappropriate for young children when they are still in their pre-or-concrete operational stages of development, a period during which they require hands-on-activities for learning to take place. Teachers are hopeful that one day ‘6 Bricks’ will filter into the curriculum.
Chapter Five - Discussion, Conclusions and Recommendations

Research shows that the pressure to accelerate young children’s academic learning (Lockhart, 2010), the priority given to the early acquisition of academic skills (Zigler, 2004), and the growing demands for teacher accountability and measurable outcomes are pushing play to the periphery of the curriculum (Bodrova & Leong, 2003). However, Bergen (2002) maintains that when children are properly supported in their play, the play does not take away from learning but contributes to it. Chaves (2015, p. 7) writes “For learning to take place as we perform other tasks, these other tasks must be fun and interesting, and to be fun, they must also be challenging. When tasks are fun, interesting and challenging, they become intrinsically motivating and engaging.”

The interview data generated in this study suggest that that teachers agree with the above and view play as an efficient, powerful, and productive way to learn (Wardle, 2007). The teachers mentioned that they were amazed at just how much one could do and achieve with just 6 bricks, and the amount of learning that took place while having fun and playing at the same time. The most pertinent response to support their assertions was:

“I mean to play with LEGO bricks and just 6, that’s it! And they loved it. I mean just putting it in colour order. I’d like to say thank you for the opportunity because we really did have a great time and I could see the kids developing. And I could see the kids loving it and I think that’s what it’s all about. To love something and to learn while doing it is such a huge deal, its huge for the kids. I mean you learn while playing, for them that was just insane. And as much as yes, I was worried about time and all that kinda stuff, I wanted then to play, I wanted them to have fun and they really did!”

(TS5:C3)

Lastly, the ‘6 Bricks’ approach provided an opportunity for teachers to reflect on their teaching. They stated that they should not take for granted that learners understand instructions
the first time they are given or understand them in the same way. They came to the conclusion that they need to give more than one example when explaining; to demonstrate rather than just dictate an instruction; to think very carefully about their instructions; and to give instructions slowly and carefully so learners comprehend. Most of all, they realised just how much learners need fun and play to learn:

“*It encouraged me to be a little more inventive and fun, try to make the teaching more fun*” (TS5:C3)

“I think a lot of them needed visualise instructions and by looking at the bricks and following what they had to build or what they had to design, they’ve learnt to not only listen now but visually look and see what is expected of them. So I don’t know, I think maybe I show a lot more now than I did before. It’s not just giving an instruction, it’s actually showing because I realise there are some children who need that” (TS3:C2)

5. **LIMITATIONS**

The findings of the study should be viewed in light of the following limitations. The sample that participated in this study was limited to five schools where the medium of instruction is English. The selection of learners and teachers was made on the basis of purposive convenience sampling, with learners already assigned to Grade 2 classes, which undermines the notion of random selection. While this limitation was catered for in the statistical analyses by considering issues of covariance, the schools, learners and teachers who participated in this study cannot be considered to be representative of South African schools, and as such no claim is made that the findings can be generalised. Nevertheless, the findings do provide insights as to what can be expected to be achieved when working with Grade 2 learners in similar schools.
Implementation of the intervention was constrained as most of the teachers were unable to complete all of the allocated 45 ‘6 Bricks’ activities and the 10 extra activities for ‘6 Bricks with exploratory talk’. This experience is consistent with the view that many teachers hold that play activities are of secondary importance to specific academic content such as literacy and numeracy via direct teacher instruction, or even that play and learning are mutually exclusive (Bodrova & Leong, 2003; Hewes, 2007; Wardle, 2007).

It is also apparent that the ‘6 Bricks with exploratory talk’ workshop may not have provided sufficient preparation for all of the teachers and that the intervention period of 6 months may have been too short and with too few activities for most teachers and learners to effectively engage in exploratory talk. While a number of studies carried out in South Africa (Sepeng, 2010; Villanueva, 2010; Webb, 2010; Webb & Treagust, 2006) teachers were able to effectively engage their learners in exploratory talk during science and mathematics inquiry activities over a period of 6 months, the learners in this study were younger than those in the studies cited above. Also, Poock et al. (2007) point out that an extended duration of exposure to any intervention is required before one can expect to see meaningful changes. As such, longer exposure and more activities might have produced greater insights and more statistically and practically significant changes than what were revealed in this study.

Nevertheless, the findings of this study appear sufficiently robust and statistically motivated to make a contribution to current international research on the possible effects that construction play (in the forms of guided play and guided play that employs exploratory talk) using the ‘6 Bricks’ approach has on the development of learners’ visual perception and reasoning abilities. The findings are also relevant in that they contribute to an empirically grounded framework for recommendations for further research on the topic in the South African context.
6. **RECOMMENDATION FOR FURTHER RESEARCH**

As noted above, the sample in this study was restricted to five schools with a limited number of learners and teachers. As such, engaging in similar research on a larger scale, e.g. with more schools, a greater variety of schools such as urban and rural, and a larger number of learners, would appear to be a profitable route towards consolidating and investigating more deeply some of the issues raised in the research findings. Also, as mentioned above, a longer duration for testing the intervention might produce more nuanced results and it would be interesting to carry out a longitudinal study from Grade R to Grade 3 looking at the effects of ‘6 Bricks’ on the development of visual perception and the effects of ‘6 Bricks with exploratory talk’ on the development of reasoning abilities across the Foundation Phase band where, as noted earlier, there is a paucity of data on the effects of exploratory talk in general and on the use of the ‘6 Bricks’ approach in particular. Studies aimed at identifying the efficacy of activities designed to develop specific areas of visual perception should also add value, as would deeper probing of teachers’ experiences and perceptions regarding the ‘6 Bricks’ approach.

Improvements in learners’ visual perception and reasoning abilities were measured in this study, but their relationship to the development of these attributes to numeracy and literacy abilities were not. Findings on possible relationships between visual perception, reasoning abilities, literacy and numeracy would contribute to the debate where such relationships are often assumed, and more clearly reveal the potential and limitations of the ‘6 Bricks’ approach to promote these skills. Also, as the majority of the children in the schools in this study have isiXhosa as their home language, but are taught in English, investigating exploratory talk in the children’s home language, as was done by Webb and Mayaba (2010), might produce results which are interesting in terms of language and disciplinary literacies, as well as comparisons
on the effects of using home language compared to the language of teaching and learning in these types of schools.

Further research in these areas described above should provide deeper insights as to the efficacy of the ‘6 Bricks’ approach as a teaching and learning strategy to develop learners’ visual perception and reasoning abilities, reveal opportunities for providing affordances for best developing these skills where other educational methods cannot, and help develop pointers and uncover prerequisites for further developing and refining learners’ visual perception and reasoning abilities during middle childhood.

7. CONCLUSION

The findings of this study reveal that guided play using the ‘6 Bricks’ approach can promote aspects of visual perception in Grade 2 learners, with the most noticeable improvements being in sequential memory, visual memory and position-in-space. This claim is backed by both the quantitative and qualitative data generated. There were also indications from the teachers concerned that they believed that these improvements were transferred into other aspects in the classroom such as concentrating, resisting distraction, logical thinking, listening and remembering instructions.

The findings also suggest that Grade 2 teachers can successfully facilitate exploratory talk among their learners, and that the ability to engage in this type of productive discussion resulted in improved reasoning as reflected by statistically significant improvements in class group mean scores on the Raven’s Coloured Progressive Matrices test. This claim can be made despite the fact that the combined change in mean scores for all classes where the facilitation of exploratory talk was attempted were lower than the change in scores of the experimental group that used the ‘6 Bricks’ approach without exploratory talk. The argument for this claim is that there were statistically and practically significant positive changes in the mean scores of
the two classes where exploratory talk was successfully facilitated. In contrast, the changes in mean scores were much lower in the classes where teachers attempted, unsuccessfully, to facilitate exploratory talk. This outcome is tentatively attributed to observations and teacher reports that trying to facilitate exploratory talk (unsuccessfully) was disruptive and counterproductive to achieving thoughtful play with the ‘6 Bricks’. These teachers explained that they found facilitating exploratory talk to be very different to their normal way of teaching and that they struggled to relinquish control of the learning process.

The participating teachers’ expressed perceptions regarding the ‘6 Bricks’ approach were overwhelmingly positive. They pointed out that they believed that playing, building, constructing, and deconstructing with the ‘6 Bricks’ contributed to the development of their learners’ physical, social, emotional, cognitive, intellectual, linguistic, and creative domains. During their reflections on the intervention they highlighted a growing realisation of the importance of bringing play back into the classroom and curriculum, and that they had come to view the ‘6 Bricks’ approach as an efficient, powerful, and productive way to learn. They expressed amazement at just how much they could do with 6 bricks and the pleasure, fun, enjoyment, laughter and the opportunity to play it brought about.

An outcome of this study, which was not one of its original objectives, was producing a computerised version of the Visual Perceptual Aspects Test (VPAT) which included the ability to measure other aspects of interest to educational psychologists. These aspects are described and explained by Clutten (2009) in her dissertation based on the development of ‘pencil-and-paper’ version of the test. Doing so was no easy task as it included assessing learners on certain subtest items specific to a particular grade, timing the responses of learners on separate items, and other issues that were not within the scope of this study. As such, a digitally-based VPAT test is now available that opens up possibilities for other researchers.
interested in the development of visual perception in younger children which can be used in broader and more nuanced ways than was done in this study.

As discussed earlier, the development of visual perception, which is essential for the acquisition of numeracy and literacy proficiency, as well as reasoning abilities necessary for the development of higher-order cognitive skills, plays an important role at Foundation Phase level. This research study therefore aimed at investigating the effect of guided play and guided play with exploratory talk when using the ‘6 Bricks’ approach on the development of visual perception and reasoning abilities in children between the ages of 8-9 years. It is hoped that the findings in this study will make a meaningful contribution to the literature on the development of visual perception and reasoning, and the underpinning practices that contribute to attaining higher-order cognitive skills.
REFERENCES


adult cohorts have implications for physical, social, and academic development. Poster presented at the annual meeting of the Association for Psychological Science, Chicago, IL.


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Wegerif & P. Scrimshaw (Eds.), *Computers and talk in the Primary classroom* (pp. 49–65). Clevedon: Multilingual Matters.


References


APPENDIX A

‘6 BRICKS’
APPENDIX B

POSTER: RULES OF THE GAME

Rules of the Game

1. Everyone must think about what they have been asked to do
2. Everyone must say what they think
3. It is ok to think differently
4. Remember to be polite
5. Listen carefully to the others
6. Agree with the best answer

Let's be Polite
## APPENDIX C

### TEACHER RECORD SHEET ‘6 BRICKS’

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of blocks used</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learners completion of activity</td>
<td>Fully</td>
<td>Partially</td>
<td>Not at all</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learners’ understanding of activity</td>
<td>Fully</td>
<td>Partially</td>
<td>No Understanding</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Learners’ enjoyment of activity | 😊 | 😊 | 😞 | 😞 | 😞 | 😞 |

<table>
<thead>
<tr>
<th>Comment (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX D

### TEACHER RECORD SHEET: ‘6 BRICKS WITH EXPLORATORY TALK’

**Teacher Record Sheet:** Ground Rules for ‘6 Bricks with Exploratory Talk’

**Key:**
- Yes (✓)
- Partial (●)
- No (✗)

**Activity Name:** ___________________________

<table>
<thead>
<tr>
<th>Rules</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Group 6</th>
<th>Group 7</th>
<th>Group 8</th>
<th>Group 9</th>
<th>Group 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All relevant information must be shared</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Groups must try to reach agreement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Everyone in the group must take responsibility for the final decision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Good reasons for the decision are expected</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. It is acceptable to challenge others ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Alternative ideas must be discussed before a decision is taken</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Everyone must be encouraged to speak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E

RESEARCHER’S OBSERVATION: ‘6 BRICKS’

Classroom Observation Checklist: ‘6 Bricks’

School: ____________________________  Teacher: ____________________________
Activity name: ____________________________  Number of bricks used: _________
Duration of observation: ____________  Date: ____________________________

Descriptive Notes: ........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................

Reflective Notes: ........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
........................................................................................................
### APPENDIX F

#### RESEARCHER’S OBSERVATION: ‘6 BRICKS WITH EXPLORATORY TALK’

**Classroom Observation Checklist: ‘6 Bricks with Exploratory Talk’**

| School: ________________________________ | Date: ________________________________ |
| Teacher: ______________________________ | Activity name: ______________________ |
| Number of learners per group: __________ | Duration of observation: ______________ |

<table>
<thead>
<tr>
<th>Criteria A: Teacher’s explanation of activity</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Unclear</td>
<td>Needs clarification</td>
<td>Clear</td>
</tr>
<tr>
<td></td>
<td>........................................................................</td>
<td>........................................................................</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria B: Teacher recaps exploratory talk ground rules</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>None of the rules</td>
<td>Some of the rules</td>
<td>All the rules</td>
</tr>
<tr>
<td></td>
<td>........................................................................</td>
<td>........................................................................</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria C: Learners’ adherence to exploratory talk ground rules</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>No rules adhered to</td>
<td>Some rules adhered to</td>
<td>All rules adhered to</td>
</tr>
<tr>
<td></td>
<td>........................................................................</td>
<td>........................................................................</td>
<td></td>
</tr>
<tr>
<td>Criteria D: Learners’ work in groups</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>No interaction</td>
<td>Limited interaction</td>
<td>Extensive interaction</td>
<td></td>
</tr>
</tbody>
</table>

Description: ……………………………………………………………………………………………………………………………………………………..

<table>
<thead>
<tr>
<th>Criteria E: Learners partaking in exploratory talk</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little to no evidence of exploratory talk indicators</td>
<td>Some evidence of exploratory talk indicators</td>
<td>Sufficient evidence of exploratory talk indicators</td>
<td></td>
</tr>
</tbody>
</table>

Description: ……………………………………………………………………………………………………………………………………………………..

<table>
<thead>
<tr>
<th>Criteria F: Learners’ level of exploratory talk</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Surface</td>
<td>Deep</td>
<td></td>
</tr>
</tbody>
</table>

Description: ……………………………………………………………………………………………………………………………………………………..

<table>
<thead>
<tr>
<th>Criteria G: Learners’ completion of activity</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not completed</td>
<td>Partially completed</td>
<td>Completed</td>
<td></td>
</tr>
</tbody>
</table>

Description: ……………………………………………………………………………………………………………………………………………………..
Appendix F
APPENDIX G

INTERVIEW QUESTIONS: VISUAL PERCEPTION

Interview Questions: Visual Perception

- The computerised tests consists of nine visual perceptual aspects which include:

  - visual discrimination – what is similar or different in form (e.g. the formation of letters and numbers, shapes),
  - visual form constancy – recognising a form whether presented in a different way, colour (e.g. a capital letter and a lower case letter, words like bad and bed),
  - visual memory – (to remember what was visual seen e.g. spelling, copying from the board, multiplication),
  - visual sequential memory (counting in 2’s or 3’s),
  - visual spatial relationships – the directionality (e.g. was and saw, spacing when writing),
  - position-in-space – matching to forms in the directionality
  - visual closure,
  - visual figure-ground, and
  - visual analysis and synthesis.

1) Which visual perceptual aspect do you think improved the most through ‘6 Bricks’?
2) Which visual perceptual aspect do you think improved the least through ‘6 Bricks’?
3) Do you think the visual perceptual aspects transferred across into the classroom?
APPENDIX H

INTERVIEW QUESTIONS: EXPLORATORY TALK

Interview Questions: Exploratory Talk

1) Do you believe that exploratory talk actually happened in your classroom?

2) Do you believe that the children actively engaged in exploratory talk?

3) If so, at what level were they engaged in exploratory talk? Deep, surface, none?

4) Did you talk less and the children more when you facilitated exploratory talk in your class?

5) Were the children able to adhere to the rules? Which rule did they comply with the most? Which rule did they comply with the least?

6) Were they able to successfully complete the activities?

7) What is your opinion regarding exploratory talk?

8) Will you continue with it in the future?
APPENDIX I

INTERVIEW QUESTIONS: ‘6 BRICKS’

Interview Questions: ‘6 Bricks’

- How many years have you been teaching foundation phase?
- How many years have you been teaching grade 2?
- Have you used Duplo in your teaching before?

1) Was Duplo a part of your classroom environment before this particular intervention? If so, was it used for general play or was it used for specific activities aimed at developing specific concepts?
2) Did you manage to do an activity three times each week?
3) How long did each activity take on average?
4) Did the learners remind you to do these activities?
5) Did you enjoy these activities - did the learners enjoy the activities?
6) Did the learners remain excited by the Six Bricks activities throughout the intervention or did they become bored or distracted?
7) Do the activities help the learners to focus or do you think they were a distraction or caused conflict?
8) Were your learners more engaged? Were they able to focus and concentrate for a period of time? If so, how long would you say their attention span lasted?
9) Do you think there were changes in terms of self-regulation and inhibitory control?
10) Did you use the Six Bricks to help the learners grasp other concepts, other than the ideas that were given to you?
11) What do you think are some of the skills learners learn when using Six Bricks?
12) What did your learners enjoy most about ‘six-bricks’?
13) Apart from the activities, did you allow them to play with the ‘Six-Bricks’?
14) Has using the Six Bricks changed the way you think about things, or the way you teach the learners within your class environment?
15) What challenges or obstacles did you encounter when you taught with Six Bricks?
16) Would you like to do these activities with other classes that you have in the future?
17) Is there anything else you would like to add?
To whom it may concern

Re - Permission to use CFE content and materials

Dear Sir / Madam

This serves to confirm that Care for Education and Hands On Technologies has given Amina Brey permission to use our content, resources, printed material and all activities for the purposes and duration of her intervention and studies.

Most of the content / activities are from the Back to Basics with Six Bricks book, but some may be from other books in the Back to Basics range, Builder 1, Builder 2 and other training material / resources we have developed and shared with her.

Please feel free to contact me if you have any queries in this regard.

Kind Regards

Brent Hutcheson
Director – Care for Education & Hands on Technologies
To whom it may concern

RE: PERMISSION TO USE MY DEVELOPED VISUAL PERCEPTUAL ASPECTS TEST (VPAT)

I, Sylvia Catherina Clutten hereby grant Amina Brey permission to use my Visual Perception Assessment Test (VPAT) for the purpose of her research.

I was initially contacted by this particular student in September 2014 after she discovered my dissertation entitled: The Development of a Visual Perception Test for Learners in the Foundation Phase. We were afforded the opportunity to meet in Port Elizabeth to discuss this assessment tool, its development and testing procedure. Further discussion addressed how best she could use the VPAT for her planned research. I therefore grant her permission to computerise the VPAT for a more effective application.

I wish Amina all the best in her endeavours in her research.

Sylvia Clutten
Educational Psychologist
APPENDIX L

ETHICS APPROVAL

Ref: [H14-EDU-ERE-014/Approval]
Contact person: Mrs U Spies

14 November 2014

Prof P Webb
Faculty: Education
School for Education, Research and Engagement
South Campus

Dear Prof Webb

THE EFFECT OF CONSTRUCTION PLAY ON THE DEVELOPMENT OF VISIO-SPATIAL ABILITIES, REASONING AND EARLY MATHEMATICAL SKILLS

PI: Prof P Webb
PI: Mr A Brey

Your above-entitled application for ethics approval served at Research Ethics Committee (Human).

We take pleasure in informing you that the application was approved by the Committee.

The ethics clearance reference number is H14-EDU-ERE-014 and is valid for three years. Please inform the REC-H, via your faculty representative, if any changes (particularly in the methodology) occur during this time. An annual affirmation to the effect that the protocols in use are still those for which approval was granted, will be required from you. You will be reminded timely of this responsibility, and will receive the necessary documentation well in advance of any deadline.

We wish you well with the project. Please inform your co-investigators of the outcome, and convey our best wishes.

Yours sincerely

[Signature]

Prof CB Cilliers
Chairperson: Research Ethics Committee (Human)

cc: Department of Research Capacity Development
    Faculty Officer: Education
APPENDIX M

APPROVAL TO CONDUCT RESEARCH

Ms Amina Bray
Researcher
c/o Prof Paul Webb
Supervisor
NMU
Port Elizabeth
Email: Paul.Webb@nmu.ac.za // Amina.Bray@nmu.ac.za

Dear Ms Bray,

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN DEPARTMENTAL SCHOOLS: PORT ELIZABETH

I refer to your letter dated 31 March 2015 and received on the 10th April 2015.

Permission is hereby granted for you to conduct your research on the following conditions:

1. Your research must be conducted on a voluntary basis.
2. All ethical issues relating to research must be honoured.
3. Your research is subject to the internal rules of the school, including its curricular programme and its code of conduct and must not interfere in the day-to-day routine of the school.

Kindly present a copy of this letter to the principal as proof of permission.

I wish you good luck in your research.

Yours faithfully,

M.W. HLEKANI
ACTING DISTRICT DIRECTOR: PORT ELIZABETH

14 April 2015

Building blocks for growth
APPENDIX N

LETTER OF INVITATION TO SCHOOL PRINCIPALS & SCHOOL PRINCIPAL CONSENT FORM

The Effect of Construction Play on the Development of Visuo-spatial Abilities, Reasoning and Early Mathematical Skills

Project Information Statement/Letter of Invitation to School Principals

My name is Amina Brey, and I am a doctoral student at the Nelson Mandela Metropolitan University (NMMU). I am conducting research on the development of early mathematical skills under the supervision of Professor Paul Webb. The Provincial Department of Education has given approval to approach schools for my research. A copy of their approval is attached with this letter. I invite you to consider taking part in this research. This study meets the requirements of the Research Ethics Committee (Human) of the NMMU.

Aims of the Research
The research aims to:

- To investigate the effect that construction play has on the development of learners’ visuo-spatial abilities, reasoning and early mathematical skills
- To compare the degree to which construction play develops visuo-spatial abilities, reasoning and early mathematical skills
- To determine teachers’ perceptions regarding construction play and its effects, and
- To determine teachers’ perceptions regarding exploratory talk and its effects

Significance of the Research Project
The research is significant in three ways:

- It will provide credible information to assist all educational stakeholders, departmental officials, district officers, principals and educators to better understand the theoretical underpinnings of the ways, methods and strategies that strengthen and improve the quality of teaching and learning of particular aspects of mathematics
- It will provide information as to how construction play can develop visuo-spatial abilities, reasoning and early mathematical skills
- It will provide a deeper understanding about teachers’ perceptions of construction play and exploratory talk and their effects

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Appendix N

Benefits of the Research to Schools

- Dissemination of results to schools, Eastern Cape Department of Education via a copy of the thesis and a journal article
- The results will inform curriculum development in mathematics education via the findings published in the thesis and in a journal article

Research Plan and Method

The intervention will require teachers to use the Duplo Blocks provided to engage their learners in 5-10 minute activities three times a week over a period of six months. Corsi Block, Raven’s Coloured Progressive Matrices and mathematical tests will be used as grade two pre-post- tests (before and after the intervention) to generate data on visuo-spatial abilities, reasoning and early mathematical skills. Permission will be sought from the school principals, teachers and parents prior to learner participation in the research. The psychological tests will be administered by members of the Department of Psychology at the NMMU (via Professors Diane Elkowine and Chris Hoelsen) and the mathematics tests by the teachers supported by the researcher.

The data generated will be analyzed quantitatively and qualitatively where appropriate. All data generated will be treated in strictest confidence and neither the school, or the teachers or individual learners will be identifiable in any written reports. The teachers will assign the learners with pre-post- test identifiers but will not be privy to the test results. As such, the researcher will not be able to identify any particular learner’s scores. The testing is not aimed at identifying possible individual changes in scores, but is investigating changes in group mean scores which may be attributable to the intervention. Participants may withdraw from the study at any time without penalty. The role of the school is voluntary and the school may withdraw from participating at any time without penalty.

School Involvement

Once I have received your consent to approach teachers and learners’ parents to participate in the study, I will
- arrange for informed consent to be obtained from participants (teachers and parents)
- arrange a time with your school for meetings with the teachers and data collection to take place

Further information

Attached for your information are copies of the Consent Form and also the Participant Information Statement.

Invitation to Participate

If you would like your school to participate in this research, please complete and return the attached form.

Thank you for taking the time to read this information.

Amina Brey  
Researcher  
NMMU

Prof Paul Webb  
Supervisor  
NMMU
The Effect of Construction Play on the Development of Visuo-spatial Abilities, Reasoning and Early Mathematical Skills

School Principal Consent Form

I give consent for you to approach my Mathematics teachers and learners to participate in the research project investigating ‘the effect of construction play on the development of visuo-spatial abilities, reasoning and early mathematical skills’.

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- I may decide to withdraw the school’s participation at any time without penalty
- Mathematics teachers will be invited to participate and that permission will be sought from them
- Only learners whose parents consent will participate in the project
- All information obtained will be treated in strictest confidence
- Names will not be used and individual learners will not be identifiable in any written reports about the study
- The school will not be identifiable in any written reports about the study
- Participants may withdraw from the study at any time without penalty
- A report of the findings will be made available to the school
- I may seek further information on the project from Amina Brey on 0834527527

__________________________  __________________________
Principal                           Signature

__________________________
Date

Please return to: 26 Driedoorn Street, Malabar, Port Elizabeth, 6020
APPENDIX O

PARENT INFORMED CONSENT FORM

Dear Parent/Guardian

I am currently a doctoral student at the Nelson Mandela Metropolitan University (NMMU) under the supervision of Professor Paul Webb. The focus of my research is to gain a better understanding of the effect that construction play has on the development of young children’s reasoning and visual perception abilities. Reasoning and visual perception play a crucial role in the development of early mathematical skills which contribute to mathematical success.

During this research project, your child’s teacher will use 6 Duplo Blocks to conduct 5 -10 minutes of guided play intervention activities. These activities will be conducted three times a week over a period of six months. This is therefore a friendly request to you, as the parent or guardian, to allow your child to participate in this research project. Consent to conduct my research has been granted by your child’s principal and teacher as well as the Provincial Department of Education.

By granting your child permission, your child will be asked to complete child-friendly computer activities on reasoning and visual perception abilities prior to and after the intervention. The assessment will take place during school hours in the presence of the computer teacher, and should not exceed an hour.

The teacher will not know any individual child’s assessment score nor will I know which score applies to any particular child as each child will be assigned a number. The aim of the assessment is solely to determine possible changes in the average scores of the class. Assurance is given that throughout this study the data collected will remain anonymous and confidential and will be used solely for my research project with the aim of facilitating the development of young childrens’ reasoning and visual perception abilities in the future.

If you consent to your child participating in this research project, please complete the attached reply slip and return it to your child’s teacher. Should you have any queries, please do not hesitate to contact me at the number below.

Yours sincerely

Amina Brey (Researcher)
Faculty of Education (NMMU)
0834527527

24 April 2015
CONSENT OF PARENT/GUARDIAN

I, ________________________________________________________________________, parent/guardian of _______________________________________________________________________, (child’s name) in grade __________, hereby give consent for my child to participate in the above-mentioned research project.

Please tick the dominant language spoken at home:

<table>
<thead>
<tr>
<th>Home language</th>
<th>English</th>
<th>Afrikaans</th>
<th>isiXhosa</th>
<th>Other (Please specify):</th>
</tr>
</thead>
</table>

Parent/Guardian Signature: ________________________________ Date: __________________________
APPENDIX P

TEACHERS’ INFORMED CONSENT FORM

NELSON MANDELA METROPOLITAN UNIVERSITY
INFORMATION AND INFORMED CONSENT FORM

<table>
<thead>
<tr>
<th>RESEARCHER’S DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of the research project</td>
</tr>
<tr>
<td>Reference number</td>
</tr>
<tr>
<td>Principal investigator</td>
</tr>
<tr>
<td>Address</td>
</tr>
<tr>
<td>Postal Code</td>
</tr>
<tr>
<td>Contact telephone number (private numbers not advisable)</td>
</tr>
</tbody>
</table>

A. DECLARATION BY OR ON BEHALF OF PARTICIPANT

<table>
<thead>
<tr>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
</tbody>
</table>

| l, the participant and the undersigned |
| ID number |
| OR |
| l, in my capacity as (parent or guardian) |
| of the participant [full names] |
| ID number |
| Address [of participant] |

A.1 HEREBY CONFIRM AS FOLLOWS:

<table>
<thead>
<tr>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<p>| l, the participant, was invited to participate in the above-mentioned research project |
| that is being undertaken by Amina Brey |
| from The Faculty of Education |
| of the Nelson Mandela Metropolitan University. |</p>
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Aim</td>
<td>That she is investigating the effect that construction play has on the development of learners' visuo-spatial abilities, reasoning and early mathematical skills and that she will use the information for her doctoral project.</td>
</tr>
<tr>
<td>2.2 Procedures</td>
<td>That I am expected to engage my learners in 5-10 minute activities three times a week over a period of six months using the Duplo Blocks provided by the project. I will be trained to carry out this process and my learners will undergo pre- and post-testing (Corsi Blocks, Raven’s Coloured Progressive Matrices, short early mathematics tests).</td>
</tr>
<tr>
<td>2.3 Risks</td>
<td>That no risks are expected</td>
</tr>
<tr>
<td>2.4 Possible benefits</td>
<td>That, as a result of my participation in this study, I will be provided with information that emanates from this study in the form of a dissertation and possible research papers which may inform my teaching practice.</td>
</tr>
<tr>
<td>2.5 Confidentiality</td>
<td>That my identity will not be revealed in any discussion, description or scientific publications by the researcher.</td>
</tr>
<tr>
<td>2.6 Access to findings</td>
<td>Any new information or benefit that develops during the course of the study will be shared as follows: (i) Doctoral thesis (ii) Possible journal article</td>
</tr>
<tr>
<td>2.6 Voluntary participation/refusal/discontinuation</td>
<td>My participation is voluntary and I am aware that I may withdraw from the research study at any time. My decision whether or not to participate will in no way affect my present or future care/employment/lifestyle</td>
</tr>
</tbody>
</table>

3. THE INFORMATION ABOVE WAS EXPLAINED TO ME/THE PARTICIPANT BY:

Amina Brey

<table>
<thead>
<tr>
<th>Language</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afrikaans</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td></td>
</tr>
<tr>
<td>Xhosa</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

and I am in command of this language, or it was satisfactorily translated to me by

(name of translator)

I was given the opportunity to ask questions and all these questions were answered satisfactorily.

4. No pressure was exerted on me to consent to participation and I understand that I may withdraw at any stage without penalisation.

5. Participation in this study will not result in any additional cost to myself.
### Appendix P

#### A.2 I HEREBY VOLUNTARILY CONSENT TO PARTICIPATE IN THE ABOVE-MENTIONED PROJECT:

<table>
<thead>
<tr>
<th>Signed/confirmed at</th>
<th>on</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Signature of witness:**

**Full name of witness:**

**Signature or right thumb print of participant:**

#### B. STATEMENT BY OR ON BEHALF OF INVESTIGATOR(S)

1. **Amina Brey** declare that:

2. He/she was encouraged and given ample time to ask me any questions:

   This conversation was conducted in
   - Afrikaans
   - English
   - Xhosa
   - Other

3. And no translator was used OR this conversation was translated into
   - (language) by (name of translator)

4. I have detached Section D and handed it to the participant:
   - YES
   - NO

<table>
<thead>
<tr>
<th>Signed/confirmed at</th>
<th>on</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Signature of interviewer:**

**Signature of witness:**

**Full name of witness:**
# APPENDIX Q

## PERMISSION FROM NCS PEARSON

![Invoice Image](image_url)

---

**INVOICE**

**BILL TO:**

- PAUL WEBB
- NELSON MANDELA METRO UNIV
- SOUTH CAMPUS
- UNIVERSITY WAY
- SUMMERSTRAND
- PORT ELIZABETH 6001
- SOUTH AFRICA

**LOCATED AT:**

- NELSON MANDELA METRO UNIV
- SOUTH CAMPUS
- UNIVERSITY WAY
- SUMMERSTRAND
- PORT ELIZABETH 6001
- SOUTH AFRICA

**INVOICE NUMBER:** 10751872

**DATE:** 15-JUN-10

**TERMS:** Net 30

---

## PURCHASE INFORMATION

**PURCHASE ORDER:**

**SHIP DATE:** 15-JUN-10

**SHIP TO:** NELSON MANDELA METRO UNIV
- SOUTH CAMPUS
- UNIVERSITY WAY
- SUMMERSTRAND
- PORT ELIZABETH 6001
- SOUTH AFRICA

---

## SHIPPING INFORMATION

**CARRIER:** SWAY

**BILL NUMBER:** 0

---

## PAYMENT INFORMATION

**NET 30**

**DUE DATE:** 15-JUL-10

**CONTACT:** 000-000-0000 (Toll Free)
010-000-0000 (FAX)

---

### DESCRIPTION

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QTY</th>
<th>UNIT PRICE</th>
<th>EXTENDED PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0150282254 RAVENS PSYC PRODUCTS PERM FEE</td>
<td>Each</td>
<td>7.00</td>
<td>3,022.30</td>
</tr>
</tbody>
</table>

**INVOICE SUMMARY:**

- **TOTAL FOR ALL LINE ITEMS:** 3,022.30
- **0.00% INTL. TAX:** 0.00

Terms and Conditions are modified by those contained in a license agreement between NCS Pearson and Nelson Mandela Metropolitan University until 12-31-17.

---

**SUBTOTAL:** 3,022.00

**TAX:** 0.00

**TOTAL:** 3,022.00

---

Remit by Check to:

NCS PEARSON, INC.
13036 COLLECTION CENTER DRIVE
CHICAGO, IL 60633

Remit by Wire or ACH to:

Bank of America - Account Name: NCS Pearson Inc.

A/C#: 071-000-000 NAME: NCS PEARSON INC.

Account No: 01818-0358255 0358255

(include invoice number in transmission)

---

ORIGINAL