Effectiveness of a *Let's Think!* lesson on the classification of objects among Grade R learners in one mainstream preschool in Gauteng, South Africa

By

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DECLARATION

I, Brigette Hamilton, hereby declare that the content of this research report is my own work. I have made the necessary acknowledgements and have provided references for all the sources I have used to compile this research report.

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ABSTRACT

Sorting and classifying are important skills for children to develop because of their link to reasoning abilities. In South Africa, where we have a history of dismal mathematics results, there is an emphasis on traditional methods in teaching new content and concepts in mathematics. This is not always effective for children with learning challenges in regular classrooms. By changing the methods of teaching to more practical, hands-on approaches, we should be able to cater for these children in a more supportive and effective manner. The study aimed to examine whether a *Let's Think!* lesson, using a cognitive dissonance approach, improved the classification abilities of Grade R boys. The research questions are: "How do the Grade R learners classify a group of objects before the implementation of the *Let's Think!* lesson (cognitive dissonance approach)?", "How do the Grade R learners classify a group of objects after the implementation of the *Let's Think!* lesson (cognitive dissonance approach)?" and "Is the cognitive dissonance approach effective in enhancing the classification ability among Grade R learners?". Piaget's theory of cognitive development, Vygotsky's social cultural theory, and the social disability model were adopted as the theoretical frameworks that guided the study.

Within the mixed methods paradigm, the study adopted the concurrent triangulation research design. The sample, chosen using simple random sampling, included a control group of eight boys and an intervention group of ten boys in Grade R. Quantitative data was collected by means of pre- and post-tests, in which the boys needed to sort a group of dinosaur toys and then transport vehicles, respectively. Qualitative data was collected through participant observation during the intervention, which was the *Let's Think!* lesson implemented using a cognitive dissonance approach.

The study findings indicated that the learners struggled with classification tasks before they were exposed to the cognitive dissonance approach, and furthermore that the lesson had a significant impact on the intervention group's ability to classify. The study also concludes that there was an improvement in a number of different elements of the classification of objects after the implementation of the intervention. These included the boys’ ability to understand and use mathematical language, working better in a group, understanding that they learnt from each other and a growth in positive attitude. The results particularly focused on the boys who needed extra support in the classroom, were promising in terms of using a cognitive dissonance approach to promote inclusion. The study recommends that curriculum specialists consider emphasising a cognitive dissonance approach to teaching mathematics in small groups in Grade R, as well as equipping early childhood teachers to teach concepts effectively using this pedagogy.

Key Words: *‘Let’s Think!’ programme; classification of objects; Grade R learners; mainstream preschool; cognitive dissonance; cognitive acceleration; inclusive education; teaching mathematics; Early Childhood Development*

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ABBREVIATIONS AND ACRONYMS

ADHD	Attention Deficit Hyperactive Disorder
ANA	Annual National Assessments
ANOVA	Analysis of Variance
CA	Cognitive Acceleration
CAPS	Curriculum Assessment Policy Statements
CAME	Cognitive Acceleration in Maths Education
CASE	Cognitive Acceleration in Science Education
DBE	Department of Basic Education
DoE	Department of Education
DSD	Department of Social Development
ECD	Early Childhood Development
ECE	Early Childhood Education
EE	Environmental Education
GPLMS	Gauteng Primary Language and Mathematics Strategy
ISASA	Independent Schools Association of Southern Africa
LTP	*Let's Think!* Programme
MKO	More Knowledgeable Other
NCF	National Curriculum Framework
SIAS	Screening, Identification, Assessment and Support
SPSS	Statistical Package for the Social Sciences
TIMSS	Trends in International Mathematics and Science
WITS	University of the Witwatersrand
ZPD	Zone of Proximal Development

CHAPTER ONE

INTRODUCTION

1.1. Background to the study

"The objective of any education system is to provide quality education for all learners, regardless of their socioeconomic or educational levels. All learners deserve quality education and training to provide them with opportunities for lifelong learning, the world of work, and meaningful participation in society as productive citizens" (du Plessis, 2013, p. 76).The push for inclusive education first began in 1948 with The Universal Declaration of Human Rights, which aimed to provide free elementary education to all children. However, by 1990, a significant number of children still had no access to basic education, prompting the Jomtien World Conference on Education for All. In 1994, the Salamanca Statement and Framework for Action on Special Needs Education was established, followed by the Dakar Framework for Action in 2000, which aimed to provide primary school education to every child by 2015. These international policies strongly influenced educational transformation in South Africa, with the White Paper on Education and Training in 1995 and the *Education White Paper 6: Special Needs Education – Building an Inclusive Education and Training System* (Department of Education, 2001) providing for a more inclusive education system that focused on removing barriers to learning. The shift was from 'special needs education' to 'inclusion'. The Incheon Declaration in 2015 reinforced the importance of inclusion and the ideals from the Salamanca Statement. In 2014, the Department of Education (DoE) published the policy on *Screening, Identification, Assessment and Support* (SIAS), which was intended to "respond to the needs of all learners in our country, particularly those who are vulnerable and most likely to be marginalised and excluded" (Department of Education, 2014).

Despite the legislation and all these policies being in place, teaching children with barriers to learning in mainstream classes remains challenging. This particularly seems to be the case regarding mathematics. This is of great consequence for early childhood education because, according to South African economists Spaull and Kotze, many researchers "have identified that students acquire learning deficits early on in their schooling careers and that these backlogs are the root cause of underperformance in later years" (Spaull & Kotze, 2015, p. 13). Moreover, children from developing countries have significant learning deficits (Spaull & Kotze, 2015). Perhaps the most noteworthy research they found is that "earlier mastery of certain cognitive, social, and emotional capabilities helps foster more efficient learning at later ages. Conversely, the lack of certain capabilities creates a low ceiling beyond which progress is improbable" (Spaull & Kotze, 2015, p. 14). Aunio, Mononen, Ragpot, and Törmänen (2016, p. 1) discuss the relevance of early numeracy skills, "especially in the initial years when much mathematics learning relies on early numeracy competence". Compared with their peers in other countries, it is clear that in South Africa, children are performing far below the expected grade levels in their first years of formal schooling and in general, South African learners attain more than one standard deviation below the mean of the rest of the world, which is the equivalent of two years of lost schooling (Spaull & Kotze, 2015; Janse van Vuuren, Herzog, & Fritz, 2018). Although it is beyond the scope of this study, it is important to mention that inclusive education policies are not being implemented properly in South Africa. Moreover, there is substantial research to explain other dismal South African mathematics results, including socio-economic circumstances, teachers' attitudes, beliefs, and knowledge, teaching load, lack of quality training, language barriers, class size, a lack of resources and so on.

The South African National Curriculum Framework (NCF) first mentions sorting for toddlers in terms of talking about items that are grouped together, progressing on to sorting objects according to their preferences for size, shape, and colour (Department of Basic Education, 2015). Children moving towards Grade R should continue to sort, classify, and make comparisons, as well as use the related language (Department of Basic Education, 2015) . Sorting is also mentioned in the ISASA Early Childhood Development Curriculum Guidelines in terms of Grade 00 and sorting according to size and colour (ISASA, 2015).The Grade R Curriculum and Assessment Policy Statement (CAPS) states that Grade Rs should "collect and sort everyday objects" and then is more specific about sorting according to only one attribute (Department of

Basic Education, 2011, p. 35). There is no mention in any of these documents of sorting according to more than one variable at a time, or the importance thereof (Department of Basic Education, 2011). To date, there is no other literature to suggest that there are problems with children understanding and implementing classification in South Africa.

The '*Let's Think!* approach is a Piagetian programme that draws on the research of Vygotsky (Shayer, 2022). There are 30 lessons to cover over the course of the Grade R year, and each lesson includes concrete preparation for the task, some sort of cognitive conflict to solve, social construction amongst the learners, and then carefully structured episodes of metacognition. These activities cover six main strains of thinking, namely seriation, classification, time sequence, spatial perception, causality, and the rules of a game. The lesson used for this study is titled "Farm Animals," and it requires children to classify pictures using a number of variables with several values. Piaget believed that cognitive development is a progressive reorganisation of mental processes that develop through maturation and environmental experience and that learning takes place through the processes of accommodation and assimilation (McLeod, 2020). Furthermore, Piaget advocated that children construct their own knowledge through experiences and discoveries and then adjust their ideas accordingly. Piaget sees cognitive conflict as one of the main drivers of cognitive development (Adey, 2008). In the *Let's Think!* programme (LTP), Piaget's theory of cognitive development is useful, but it has some limitations, as acknowledged by Piaget himself. For example, development does not always proceed smoothly and predictably, and Piaget undervalues the influence that culture has on cognitive development. We know from research that a child's sociocultural environment plays an instrumental role, and this is where Vygotsky's theories of learning are invaluable.

Vygotsky emphasised the significance of learning through social interaction and constructing knowledge by learning from others who are more knowledgeable others (MKOs). The Zone of Proximal Development (ZPD) is regarded as an educational application of Vygotsky's social model of cognitive development and states that the potential of learners can be activated through collaborative interactions, and this forms the basis of the LTP sessions (Adey, 2008). However, Vygotsky's theory of “scaffolding” is seen as counterproductive in cognitive acceleration (CA) in that it could minimise a learner’s exposure to problems and challenges, which could then reduce the lesson’s cognitive demand (Adey, 2008).

According to Shayer and Adhami (2010), each *‘Let’s Think!’* lesson has three stages. The first stage introduces the lesson context at a level where all students should be able to participate and is called concrete preparation (Shayer & Adhami, 2010). The students are then presented with a cognitive conflict, which they need to solve together with the teacher acting as a facilitator. This is the second stage, social construction, and is based on Vygotsky’s Zone of Proximal Development theory, which has been discussed (Shayer & Adhami, 2010). In the third metacognition stage, the children discuss what they have learned and how they arrived at that conclusion (Shayer & Adhami, 2010). The notion of “cognitive conflict” comes from Piaget; “social construction” is an idea developed by Vygotsky, and metacognition is the third principle, which comes indirectly from both Vygotsky and Piaget (Adey, 2008). In the 1950s, psychologist Leon Festinger proposed the concept of cognitive dissonance. In his book, “*A Theory of Cognitive Dissonance*,” Festinger’s hypothesis is that the existence of dissonance (inconsistency) would make a person psychologically uncomfortable, thereby motivating them to reduce the dissonance to achieve consonance (consistency) (Festinger, 1957).

Early Years Education in South Africa includes the education of children from birth to nine years of age, namely Early Childhood Development (ECD). It includes learners who are in pre-Grade R programmes, Grade R programmes and the Foundation Phase (Grades 1–3) and is governed by the Child Care Act 74 of 1983, which is currently under review. This is relevant because according to Martinez, Naudeau, and Pereira (2012), “the earliest years of life are pivotal in forming the foundations for healthy development”, which can be affected by deficits in health, nutrition, and poor cognitive stimulation (Martinez, Naudeau, & Pereira, 2012). This in turn leads to delayed development, which can reinforce the intergenerational transmission of poverty, which is evident in South Africa. Wingrave (2018) states that ECD is vitally important in countering the effects of social and economic disadvantage and social injustice. Grade R is particularly important in getting children ready for school in terms of cognitive, social, emotional, moral, linguistic, and physical development. In research carried out by Janse van Rensburg (2015) on the school readiness performance of a group of Grade R learners in primary schools in Gauteng, the results were dismal: In a survey investigating the profile of these classes at primary schools representing all five quintiles in two districts in Gauteng, none of the five groups of Grade R learners from different quintiles scored at the desired level of 63% or more, meaning that they were not school ready.

From personal experience, I was a Grade R teacher for 14 years and, until recently, had a class of 25 boys, between the ages of 5 and 6 years. The differences between the abilities of the boys led to an interest in what sort of lesson would work to ensure all boys had the opportunity to improve their ability to sort according to more than one variable simultaneously, despite any challenges they may be experiencing. We are moving towards inclusion in mainstream schools, and there were a number of boys in my class who have been diagnosed with ADHD, occupational therapy issues, speech challenges, language barriers, developmental delays, and such like.

I came across the *Let's Think!* programme in 2012 and was trained in implementing it by Professor Michael Shayer from the UK, who was the originator of cognitive acceleration. This programme "draws on the research of Piaget and Vygotsky and focuses on questioning, collaborative work, problem solving, independent learning, metacognition, and challenge" (Seleznyov, Adhami, Black, Hodgen, & Twiss, 2022; Adey, Robertson, & Venville, 2001). The study was based on Piaget's preoperational stage and concrete operational stage of cognitive development (children between ages 2-7 years) because the Grade R learners are either in the preoperational stage or transitioning to the concrete operational stage.

"Children's cognitive development is facilitated by interactions with more knowledgeable others" and these kinds of interactions take place in schools with trained teachers playing the role of mediators (Niklas, Cohrssen, & Tayler, 2018). According to Au, Sheehan, Tsai, Duncan, Buschkuehl and Jaeggi (2015), the consensus is that the abilities to reason, solve problems, and form concepts are critical components of intelligence, and this is what the *Let's Think!* programme seeks to develop. According to their website, the *Let's Think!* programme has been used to build opportunities for learners to find connections in learning, and their approach "develops the intelligence of pupils by improving their thinking processes". There have been several research papers published over the last thirty years regarding the effects of this programme on learning, and these include the fact that the effects are permanent, and replicable (Let's Think! Cognitive Acceleration, 2022).

However, this is seemingly the first study that has been done in South Africa on the effectiveness of using a cognitive dissonance approach for helping Grade R children learn to classify objects using more than one variable at a time.

1.2. Problem statement

"Early numeracy skills are highly relevant for children's mathematics learning at school, especially in the initial years when much mathematics learning relies on early numeracy competence" (Aunio, Mononen, Ragpot, & Törmänen, 2016). Bearing that in mind, Spaull and Kotze (2015) have indicated that our South African children are performing well below expectations in the first years of formal schooling. Janse van Vuuren et al. (2018) found a link between poor school performance and severe economic problems. Sorting and classifying are important skills to develop because of their link to children's reasoning abilities, and they support skill development in both mathematics and science. In South Africa, there is an emphasis on traditional methods for teaching new content and concepts in mathematics. This is not always effective for children with learning challenges in regular classrooms. "Among the varied challenges many classroom practitioners encounter in promoting complete inclusivity in their classrooms is the lack of ideal strategies to promote equitable learning" (Mutekwe, 2018). By changing the methods of teaching to more practical, hands-on approaches, we should be able to cater for these children in a more supportive and effective manner. Any teaching style would need to ensure enjoyment, engagement, and collaboration for children. Empirically, South Africa's Grade R programme seems to have only a little effect on children's school readiness and therefore needs to provide motivation, deeper learning, and innovation for teachers (Janse van Vuuren, Herzog, & Fritz, 2018). Many programmes developed for Grade R learners do not take these motives into account, and there may be a heavy academic and abstract drive to develop certain concepts. Providing small group tasks to improve our teaching methods and therefore improve cognitive development should show acceleration in all learners, not just those who do not require academic support. Heckman (2000, p. 5) puts it succinctly: “Policies that seek to remedy deficits incurred in early years are much more costly than early investments wisely made and do not restore lost capacities even when large costs are incurred. The later in life we attempt to repair early deficits, the costlier the remediation becomes.” It is therefore vital that we get this right during the early years.

1.3. Rationale of the study

I had experience with the *Let’s Think!* programme as part of my professional development involving lesson studies. The lessons within the programme are designed to support cognitive development by moving students progressively through Piaget’s stages of development, and they are specifically designed for Grade R children. I am of the belief that children cannot start to classify according to more than one variable independently, and it should be taught in a constructivist manner for efficacy. There were several boys in the class who were diagnosed with ADHD, occupational therapy issues, speech challenges, language barriers, developmental delays, and so on, and my experience of working with this programme is that they could benefit from this lesson. Children at risk of experiencing difficulty at school, particularly with mathematical challenges, need additional and more intensive assistance in order to develop language, and Dunphy, Shiel, Corcoran, Ryan, Travers and Perry (2014) assert that “conversations amongst children about mathematical ideas are also important for mathematical development” (Dunphy, et al., 2014, p. 10).

There is currently limited research on the effects of this method of teaching. Essentially, the *Let’s Think!* programme is a cognitive acceleration programme, but it could theoretically be applied to encourage inclusive learning in the classroom while allowing children to enjoy, engage in, and collaborate in these lessons. A biproduct of applying this methodology could be professional development for teachers, making them more motivated and developing a deeper understanding of how children learn while making classrooms more effectively inclusive. It could hopefully implement a change in teaching technique, from a traditional method to a more hands-on method that is engaging for all.

1.4. Aim of the study

The aim of this study was to examine the effectiveness of using a *Let's Think!* lesson to assist Grade R learners in one mainstream boys' primary school in Gauteng to classify objects.

1.5. Research Objectives

The study was guided by the following research objectives:

a) To examine how Grade R learners classify a group of objects before the implementation of the *Let's Think!* lesson.

b) To establish how the Grade R learners classify a group of objects after the implementation of the *Let's Think!* lesson.

c) To analyse whether or not the cognitive dissonance approach is effective in enhancing the classification ability among Grade R learners.

1.6. Research questions

The following research questions guided the study.

a) How do the Grade R learners classify a group of objects before the implementation of the *Let's Think!* lesson?
b) How do the Grade R learners classify a group of objects after the implementation of the *Let's Think!* lesson?
c) Is the cognitive dissonance approach effective in enhancing the classification ability among Grade R learners?

1.7. Research hypotheses

The following research hypotheses will be tested. A *'Let's Think!'* lesson, using the cognitive dissonance approach is not effective in enhancing the classification ability among Grade R learners.

1.8. Operational definition of terms

The following terms used in the study are defined below:

Classification: This is a cognitive skill that involves the ability to group objects into sets using specific characteristics. In the present study it is significant in that the children should be able to classify according to more than one variable simultaneously after the intervention.

Cognitive acceleration: This is an approach to teaching which underpins the *Let's Think*! Programme, and is used to develop children's thinking abilities. In this study it is the method used to enhance the Grade Rs ability to classify according to more than one variable at a time.

Cognitive dissonance: This refers to an uncomfortable internal state occurring when new information conflicts with commonly held beliefs. In this present study, it will be the way in which a new concept is introduced. The children will be presented with the challenge of classifying pictures according to two variables at the same time. It will result in discussion, conversation, confusion, conflict, and discord. From this, a solution should arise, which will be that of double classification.

Early Childhood Development (ECD): This refers to the overall development of children from birth to 9 years old, encompassing their physical, mental, emotional, moral, and social growth and wellbeing. In this study it is significant because Grade R falls within this area.

Grade R learners: In the South African context, these are children starting formal school, and they are generally between the ages of 5 and 6 years old. It is the age-group specific to this study.

***Let's Think!* programme:** This is a cognitive acceleration programme that has been developed in the UK and adopted in some South African schools. It provides a series of material through which a cognitive acceleration approach to teaching thinking can be developed, using five pillars of cognitive acceleration, namely concrete preparation, cognitive conflict, social construction, metacognition, and bridging. It claims to develop the cognition of learners by improving their thinking processes in Grade R. Each activity in the Grade R programme addresses one of the schemata of concrete operations of seriation, classification, time sequence, spatial perception, causality, and rules of a game.

Mainstream schooling: This type of schooling is designed for students with mild to moderate disabilities who require minimal support. The emphasis is on providing multi-level classroom instruction to cater to the individual needs of learners.

Inclusive education: This refers to having all children, including those with disabilities and speakers of minority languages in the same classrooms and schools. Equal opportunities for everyone.

Inclusion: is the embracing of all people, regardless of their disabilities, gender, race, language, socio-economic status, or cultures. It means providing equal access and opportunities to all in order to remove barriers of any sort.

Scaffolding: is structure provided by a teacher in order to assist children in their learning processes. In this study, it is one of the teaching methods used to assist children in learning to classify objects according to more than one variable at a time.

Special schools: These schools were designed to accommodate children with high levels of support and needs. Many of them existed before to the government adopted an inclusive education policy.

Zone of Proximal Development: This is a term coined by Lev Vygotsky, and it refers to the gap between what a child can accomplish independently and what they can accomplish with guidance and support from a 'More Knowledgeable Other'. In this study, it is a pivotal part of the *Let's Think*! programme and is used in the lesson facilitating the concept of classification.

1.9. Structure of the research project

The research project is structured as follows:

Chapter One

Chapter one presents an introduction and background of the study, including an overview of inclusive education, early childhood development, our South African curriculum, and information regarding *Let’s Think!,* a cognitive acceleration programme. The problem statement, rationale, research questions, and operational definitions of terms used have been presented.

Chapter Two

Chapter two consists of the literature review and the theoretical frameworks used. The literature review provides information on early years education, the role of the teacher, inclusive education in South Africa, the mathematical concept of classification and the language that supports it, cognitive dissonance, cognitive acceleration, and the stages of this sort of lesson, as well as the debates on its effectiveness.

The theoretical frameworks discussed, and the justification thereof include Piaget’s theory of cognitive development, Vygotsky’s sociocultural theory, and the social disability model.

Chapter Three

Chapter three consists of the research design and methodology used for this study. Included is information on the research site, sampling, data collection methods, data analysis and the ethical considerations of the study.

Chapter Four

Chapter four discusses the findings of both the qualitative and quantitative data analyses.

Chapter Five

Chapter five includes the summary of findings, discussion, conclusion, recommendations, limitations of the study, and suggestions for future research in this area.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Introduction

This chapter presents the literature review and the theoretical frameworks that were adopted to guide this study. The chapter begins with a presentation of literature on early years education, the role of the teacher, inclusive education in South Africa, the mathematical concept of classification and the language that supports it, cognitive dissonance, cognitive acceleration, and the stages of this sort of lesson, as well as the debates on its effectiveness. Thereafter, the three theories namely: Piaget's theory of cognitive development, Vygotsky's sociocultural theory, and the social disability model are discussed. Finally, the relevance of the theories is discussed.

2.2. Early Years Education

Early Childhood Education (ECE) in South Africa has, until recently, taken place under two different departments: Early Childhood Development (ECD) used to function as part of the Department of Social Development (DSD), while the other grades formed part of the Department of Basic Education (DBE) (Department of Basic Education, 2015; Department of Education, 2001). There are currently two documents guiding Early Childhood Education namely the National Curriculum Framework (NCF) ensuring that children, from birth to the age of four, have access to quality Early Childhood Development (ECD) services and the Curriculum and Assessment Policy (CAPS) document which is the national curriculum for Grades R–12 (Department of Basic Education, 2015; Department of Education, 2001). There is no debate that learning in the early years is beneficial and essential, and Gordon and Browne (2017, p. 380) state that "the amount of learning that takes place in early childhood is staggering". Spaull and Kotze (2015) indicate that if certain cognitive capabilities are developed early, then learning will be more efficient when children are older, and conversely, that a lack of these capabilities make progress improbable. For example, classification in children starts early, and with the help of adults who provide opportunities for descriptions and manipulation, they can learn to classify according to more than one variable (Gordon & Browne, 2017). Janse van Vuuren et al. (

(2018)refer to predictors and precursors as the abilities and skills necessary for mathematical learning at school, with precursor skills being directly linked to mathematical concepts and therefore essential requirements for children’s development. For example, Goswami's (1998) research demonstrated that young children have an instinctive preference for learning about causal relations, which aids them in developing appropriate frameworks for organisation and logical reasoning.

2.3. Inclusive Education in South Africa

According to Vlachou and Fyssa (2016, p. 529), “inclusion supports the right of every child, regardless of ability, to participate as a full and equal member in a broad range of activities and social contexts”. And this should start as early as possible. Donohue and Bornman (2014, p. 3) state succinctly that “…the many different ethnic and language groups in South Africa, along with the country’s apartheid history and rampant poverty, contribute to a society that has many different ideas not only about the needs of children with disabilities, but also about best practices and beliefs regarding how they should be educated”. They add that children with disabilities are placed in special schools because the emphasis is incorrectly placed on their abilities and the support they require to learn in a regular school. Vlachou et al. (2016) indicated that inclusive preschool programmes provide developmental, educational, and social advantages.

Soudien (2018, p. 127) states that post South Africa’s 1994 move to democracy, it “inherited a profoundly/y discriminatory educational system”. To address this, South Africa developed various policies and legislation in line with international trends, including the White Paper on Education and Training, the White Paper on an Integrated National Disability Strategy, and the South African Schools Act (Department of Education, 2001; Department of Education, 2014). These documents uphold education as a fundamental human right, emphasising the need for equal access, relevance, and quality of education. White Paper 6, ‘Special Needs Education: Building an Inclusive Education and Training System’, outlines a framework for achieving more inclusive education in South Africa through the curriculum (Department of Education, 2001). However, school-level, and cultural barriers to learning as well as ambiguities in White Paper 6 have obstructed inclusive practice in

South Africa, with Donohue et al. (2014, p. 9) claiming that our inclusive educational policy is “characterised by both high conflict and ambiguity”. They are positive that our country will be able to overcome these obstacles, and that “the more children with disabilities are included in education and elsewhere in their communities, the sooner they can become productive and contributing members of society, showcasing their unique talents just like everyone else” (Donohue & Bornman, 2014, p. 12).

According to Human Rights Watch (2015), “inclusive education should focus on ensuring the whole school environment is designed to foster inclusion, as opposed to segregation or integration”. The Schools Act (1996) states that all children should be in school by five to six years old for Grade R or pre-school. A study by Vlachou et al. (2016) in Greece involved teacher support in terms of inclusion of children with disabilities into mainstream schools. There was no evidence to suggest that similar studies have been applied in South Africa, but it is fair to assume that the findings would be transferable, in that teachers only partially promoted participation for children with disabilities, and that further examination of preschool inclusion quality was necessary. However, because of the transition from the medical model to the social model, many teachers do not have the necessary skills to teach those with disabilities (Donohue & Bornman, 2014). Spaull et al. (2015) found few South African studies that used nationally representative samples of student achievement, and none at all when linking this to learning deficits. In addition, they highlight the lack of longitudinal data on South African learning deficits, as well as their size and distribution in the student population.

Engelbrecht (2020) reviewed research studies and reports on the implementation of the inclusive education policy in South Africa to identify the challenges and successes of this process. The research identified that although South African teachers support the justification of inclusive education in principle, the educational and economic viability of this policy is jeopardised by lack of human, technical and infrastructural resources (Engelbrecht, 2020).

2.4. The role of the teacher in ECD mathematics

2.4.1. Teacher-child relationships

The relationship between a teacher and a child is a crucial factor in a child's education and can greatly impact their learning experience. Previous literature and various studies have suggested that teacher-child relationships are key in promoting emotional, social, and cognitive development and they have expressed the magnitude of early teacher–student relationships in fostering school adjustment and academic success (Narea, Treviño, Caqueo-Urízar, Miranda, & Gutiérrez-Rioseco, 2022). High-quality relationships between teachers and children result in pre-schoolers who are more engaged in learning and experience better school adjustment (White, 2020). Yoleri (2016) reminds us that during the preschool years, teachers are the second most prominent influence in a child's development, after that of their parents, and that children tend to listen more attentively, are more focused, and learn better when close relationships have been built. Conversely, a negative relationship between teachers and children hinders their achievements. Howie (2005) proved that a strong predictor of children's achievement is the teacher's attitude, and that their commitment plays a pivotal role in the performance of children. Similarly, in research conducted by McNally and Slutsky in urban preschools in the northern Mid-West of the United States, they found that "warm trusting teacher–child relationships are a mandatory aspect of high-quality practice" (McNally & Slutsky, 2017, p. 12).

2.4.2. Pedagogic knowledge of maths

Apart from building relationships with their children, early childhood teachers need to have a sound knowledge of mathematics. Mabena, Mokgosi & Ramapela (2021) found that, based on a study in Mpumalanga on inferior mathematics performance in Grade 9 learners, one of the factors was a "lack of pedagogical content knowledge and skill, and lack of appropriate professional training", which could be rooted in poor early years education (Mabena, Mokgosi, & Ramapela, 2021, p. 451). Teachers should be able to assess what their children understand about mathematical knowledge and concepts as well as their misunderstandings (Rudd, Lambert, Satterwhite, & Zaier, 2008). They emphasise the magnitude of preschool teachers' subject and pedagogical content knowledge, as do Baroody, Clements, Sarama, in Brown, Mcmullen and File (2019), who believe that ECD maths instruction should be effective, engaging, and holistic. Baroody et al. (2019) discuss the merits of pedagogical tools, such as learning trajectories, structured play, and integrated instruction. The study by Bold, Filmer, Martin, Molina, Rockmore, Stacy, Svensson, and Wane (2017) done in seven sub-Saharan countries, namely Kenya, Nigeria, Mozambique, Senegal, Tanzania, Togo, and Uganda, painted a concerning picture of teaching effort, knowledge, and skills in Africa. The challenge lies in having competent subject knowledge and knowing how to translate it into effective pedagogy.

In 2016, Fleisch, Schöer, Roberts and Thornton published their results on the Gauteng Primary Language and Mathematics Strategy (GPLMS), which was developed in 2010 (Fleisch, Schöer, Roberts, & Thornton, 2016). This strategy used a combination of data from the Annual National Assessment (ANA) results, high-quality learning support materials, instructional coaching, parental support, and scripted lesson plans in order to implement structural change. The results were positive, indicating that the combination improved efficacy. Following this, Fleisch published a book, "The Education Triple Cocktail: System-Wide Instructional Reform in South Africa" (2018), referring to the above intervention and the benefits thereof.

Hazell, Spencer-Smith, and Roberts (2019) implemented an early grade math intervention in Grade R schools in the Western Cape. The purpose was to improve the teaching and learning of math in Grade R, and thereby improve the math skills and conceptual understanding of the children to the point that they would be successful and enjoy the subject. The results of the intervention were encouraging in that the intervention group performed as well as children six months older than they.

Spaull, Courtney and Qvist (2022) worked on the premise that the mathematical skills needed to succeed in higher grades were grounded in mastering concepts taught in earlier grades. They carried out an analysis of the Grade 5 outcomes in TIMSS (Trends in International Mathematics and Science) 2015 and 2019 and discovered that the stagnation indicated in that grade in the study was due to South African teachers not understanding the mathematics they were teaching, and that they lacked pedagogical knowledge. The harsh reality is that maths teachers "have severe gaps in their knowledge of subject content … and lack conceptual understanding of even primary school mathematics content" (Spaull, Courtney, & Qvist, 2022), which is reflected in our country's math results. This is consistent with the findings of Setoromo, Bansilal, and James (2018) on Grade R teachers' mathematical knowledge in relation to teaching numeracy in Lesotho, which were dismal. Mampane (2018, p. 189) highlights the significance of teachers having appropriate subject knowledge and professional development to carry out the teaching and learning tasks expected of them in our South African mathematics curriculum effectively, as it is currently inadequate. Teacher education should therefore be a priority so that our South African teachers acquire research-based knowledge and best-practice training in our early childhood curriculum. "When teachers are provided with tools and support that are deeply accountable to the language resources and instructional context of their classroom, learning and teaching improves" (Porteus, 2022).

2.4.3 The teacher's role in teaching mathematics

"The effectiveness of an activity in developing mathematical thinking is dependent on the strength of the connection that the teacher makes between students' motivations, knowledge, and competencies, and the curriculum-based goals of the activity" (Walshaw, 2017, p. 295), and quality education cannot take place without quality teaching. "The teacher should approach mathematics with enthusiasm, interest, and the ability to adapt to a constructivist, problem-centred approach" (McDermott & Rakgokong, 1996). This is in contrast to traditional classrooms, or direct-instruction classrooms, where children are passive learners and lessons are teacher-focused. The nature of constructivism is such that the teacher needs to assist each child in experiencing, hypothesising, questioning, manipulating objects, investigating, and negotiating (McDermott et al., 1996). This is done by organising the learning environment so that children construct their own knowledge, and the teacher's function changes from that of a transmitter of knowledge, to that of a facilitator of ideas and knowledge, who ensures that children partake in processes of inquiry, action, and reflection. To be able to do this, teachers need a shift in their philosophy, as well as a rigorous understanding of the constructivist philosophy, and the skills to implement these practices. In his latest research, Shayer (2022) suggests "a modest proposal" in which he advocates for the replacement of procedural teaching with a more engaged teaching practice, where all children are involved, as is the cognitive acceleration model. He rightly declares, “Try to ‘teach’ the average level, and you will lose the bottom 30% because they can’t follow, and you will lose the top 30% because they are bored, leading to trouble” (p. 146). Shayer’s proposal is that the answer is rooted in initial teacher training (Shayer, 2022).

2.4.4 ECD maths group work

It is essential for ECD teachers to know how to facilitate the learning of mathematical concepts in groups, with children arguing to find the solutions to set activities. “This attribute of cooperative learning supports the forms and approaches of constructivism essential in social constructivism” and the communication between teachers and learners will be enhanced through this, creating more meaning in mathematics (Mabena et al., 2021, p. 454). However, Veldman, Doolaarda, Boskera and Snijdersb (2020) state that “placing pupils in groups and telling them to work together will not necessarily promote cooperation,” and therefore this requires the teacher to “prepare a learning environment that is nurturing and inviting, identifying a topic of true interest to all children, selecting quality materials, and including oneself as a critical researcher and facilitator of the group” (Hong, Shaffer, & Han, 2017) Henniger (2009) advises that to ensure group experiences are positive, new guidance strategies need to be considered. Important social skills, such as taking turns, listening to others, and managing their own behaviour need considerable practice before they become habitual. For group work to be effective, the teacher needs to “have the disposition, skills, and reflective practice in order to develop metacognition, curiosity, dialogue, visible thinking, integrated inclusive play, and problem solving” which is what needs to happen during mathematics group work (Hong et al. 2017).

Research on 980 Year 1 and 2 students (aged 5 -7) in England was carried out by Kutnick, Ota and Berdondini (2008) on developing group work and the efficacy thereof, using a relational approach. Their discovery was that young children possess the capability of promoting their academic achievement through the engagement in effective group work. Furthermore, their reading and maths attainment improved, they communicated more effectively, and they were more likely to stay-on-task. Interestingly, the children themselves claimed to “think better,” “learn more” and “try harder” (Kutnick, Ota, & Berdondini, 2008, p. 92). According to Hattie (2009), utilising students' contributions in a productive manner, has a quantifiable impact on their learning progress. Some positive results were revealed in an investigation on the impact of cooperative learning among 168 Grade 1 pupils in the Netherlands by Veldman et al. in 2020, proving that it leads to better group work and increased active learning, including from each other. Prediger, Götze, Holzäpfel, Rösken-Winter, and Selter (2022) examined the principle of improved communication as a fundamental aspect of instructional quality in mathematics education and asserted that various studies demonstrate the significance of involving children in small group discussions. However, simply engaging in these sessions does not guarantee an increase in their conceptual comprehension since they must also learn *how* to communicate effectively.

2.5. Classification of objects

"There is a link between a young child's acquisition of mathematical skills and the development other academic and cognitive skills during the early years" (Purpura, Napoli, & King, 2019). "The importance of consistent classification and categorization has been recognized by psychology for at least thirty years" (Inhelder & Piaget, 1964, p. xi). Bornstein and Arterberry (2010) discuss the magnitude of being able to sort, classify and categorise because according to them, these skills facilitate our world interactions, as well as the storage and retrieval of information. They go on to say that categorisation is "an essential cognitive and developmental achievement" (2010, p. 350). They place emphasis of the value on categorisation in infancy and early childhood, because without this skill, "children would have to learn to respond anew to each novel entity they experience". Cole and Cole (2001, p. 98) claim that once a child is able to categorise according to several criteria, "there is a marked increase in the number of relations among objects and events that children can think about and increased flexibility in the particular relations they choose to use".

2.5.1. Mathematical language

The ability to classify and sort is linked to mathematical language, which, according to Purpura, Napoli, Wehrspann and Gold (2017, p. 1), is "one of the strongest predictors of children's early mathematical success". They also emphasise the important role that mathematical language plays in developing early mathematical knowledge. According to Walshaw (2017, p. 295), "much of joint intellectual activity and meaning making in

Vygotskian thinking is derived from language." In 2014, Hojnoski, Columba, and Polignano (2014) conducted a study focused on pre-schoolers and improving their mathematical language, however, they did not take mathematical knowledge into account. Purpura and colleagues then used a randomised control trial to investigate the causal relationship between these two aspects of mathematics, which had not previously been researched at the preschool level. They found that their intervention led to a noteworthy improvement in both mathematical knowledge and language skills (2017, p. 22). In another study carried out by Hornburg, Schmitt and Purpura (2018) on 124 preschoolers, the relation between mathematical language and specific numeracy skills was assessed. They particularly looked at counting, one-to-one correspondence, cardinality, ordering, and word problems. What they discovered was that the two were significantly related, and that understanding specific mathematical terms would facilitate a better understanding of more complex numerical concepts. It would be fair to assume that even though they did not focus on the specific vocabulary of sorting, classification, and categorisation, their findings would still apply.

The lack of exposure to quality mathematics-specific vocabulary is one of the reasons that South African children repeatedly perform poorly on mathematics assessments, both locally and internationally; however, there is a paucity of longitudinal research on the role of language in early grade maths (Essien, 2018). Bezuidenhout (2022) studied the effect of this in Grade 1 and 2 children from Quintile 1 schools in South Africa and found that mathematics-specific vocabulary is “a key tool for early number concept,” and therefore all teachers’ pedagogical content knowledge should include how to develop this. Purpura et al. (2019) advocate for further research on how teachers can promote the learning of both of these concepts during the preschool years, and Bezuidenhout (2022) states that the explicit teaching of mathematical vocabulary needs to be included in our Foundation Phase curriculum. Aunio et al. (2016) too suggested that language instruction and use is an important factor in ECD in South African schools, and should be researched further, particularly in the field of mathematics. In his study on the role of language in early grade mathematics and teaching in Kenya, Malawi, and South Africa (2018), Essien cast a spotlight on the cognitive benefits of understanding mathematical language in a child’s mother tongue, as well as the additional language used for teaching.

In this study, the understanding of the terms ‘sort’ and ‘classify’ lead to children engaging in the activities more meaningfully, constructively, and successfully.

2.5.2. Mathematical attitude

In this study, understanding the mathematical terms of classification and sorting is directly linked to the child’s ability to complete the given tasks. Poor execution results from a failure to understand instructions. This may then result in mathematical anxiety, a negative attitude, or avoidance. However, there are limited studies regarding pre-schoolers’ attitudes to math because of a lack of appropriate measuring instruments in children this young (Chen, et al., 2018). Chen et al. carried out a study on primary school children, and the results suggested a positive attitude towards mathematics predicted future mathematical achievement. Finau, Treagust, Won and Chandrasegaran (2018) studied the effects of a mathematics CA programme on student achievement and motivation in Tonga with 338 Year 8 students. They found that it had a positive effect on levels of students’ self-regulation, motivation, and mathematical achievement. Furthermore, the students themselves claimed that it changed the way they learned mathematics.

Dowker, Cheriton, Horton, & Mark (2019) completed a study of Year 1 children in England and Hong Kong to investigate the effect of unhappiness at failure in mathematics, focusing more on the response to failure than the anticipation of failure. Their findings indicated that a response to failure had an effect on performance. In 2020, Zhang, Yang, Zou, Hu, Bi Ying, and Ren measured pre-schoolers’ affective attitudes towards maths and stated that these attitudes are not innate but are formed from a combination of teacher and parent expectations, curriculum, teaching practices, assessment polices and their success and failure regarding mathematical tasks. Baroody et al. (2019) emphasise the need for positive attitudes and productive dispositions towards the teaching and learning of math.

2.6. Cognitive Dissonance Approach

According to Cooper and Carlsmith (2015, p. 76), “the theory of cognitive dissonance is elegantly simple: it states that inconsistency between two cognitions creates an aversive state akin to hunger or thirst that gives rise to a motivation to reduce the inconsistency". In simpler terms, it is an internal state that is caused when new information clashes with previous beliefs.

Although Piaget introduced the notion of "cognitive conflict" in the early 1900s, Festinger (1957) coined the phrase, "cognitive dissonance". Piaget's belief was that by decreasing our demands on children, we were doing them a disservice, but by providing them with challenging activities that they were supported in doing, more powerful schema could be developed (Adey, Robertson, & Venville, 2001, p. 3). Piaget (1977) and Festinger (1957) both believed that dissonance was beneficial for intellectual development and rational thinking. Adcock (2012, p. 588) maintains that cognitive dissonance can be defined by two different perspectives. She states that Festinger's stance is psychological, and Piaget holds an educational psychology perspective. The latter means that Piaget understood that cognitive dissonance could be used to facilitate the development of knowledge. Brown (2008) looked at Piaget and Festinger's theories and referred to them as the "comfort zone model." He did not find strong support in the educational literature for promoting disequilibrium or dissonance.

Zohar and Aharon-Kravetsky (2005) did some research in Israel on Grade 9 students of varying academic levels because they believed that there was inconclusive evidence to prove that teaching using cognitive conflict is effective. They decided to explore the effects of cognitive conflict as opposed to those of direct teaching. The conclusion of their research was that high-level students benefited from inducing cognitive conflict, whereas low-level students benefited from a direct teaching method. Brown (2008) claims that one cannot guarantee a cognitive dissonance state simply by placing people in stressful situations, and that students deserve to experience meaningful and authentic learning by providing them with favourable conditions. This means that much of the learning experience is dependent on how teachers present challenges. Prediger et al. (2022) talk about using a principle of cognitive demand as a way to achieve high-quality mathematics teaching. This involves creating meaningful learning environments, as well as moving away from superficial learning, having high expectations, and increasing higher-order thinking.

2.6.1. The *'Let's Think!'* programme

Adey (1988, p. 123) describes cognitive acceleration as "the application of some special procedure(s) to subjects that results in their attaining higher levels of cognitive development faster than if they had not been subjected to these procedures". In a Grade R context, this means promoting the development of children's capabilities in processing information and speeding up the process of transitioning from pre-operational to concrete operational thinking (Adey, Robertson, & Venville, 2001, p. 4). The combination of the theories of cognitive acceleration, working memory, and Piaget's theory of cognitive development were combined to form a flexible and innovative programme, '*Let's Think!',* to help teachers promote the thinking abilities of children. The programme is intended for children aged 5 to 6 years old and consists of 30 lessons that should be implemented in groups of six children at a time. The aim is to create environments where the process of cognitive development can be maximised and the development of powerful schemas can be stimulated in order to enhance future learning (Adey et al., 2001). The programme developers are of the opinion that the age of five is a critical period for promoting cognitive acceleration.

Even though the *Let's Think!* programme originated in the United Kingdom, it is designed specifically for five- to six-year-old children, not for specific grades, and is therefore applicable in South Africa. Shayer (2003) reminds us that throughout the lessons, the teacher should be cognisant of the activities regarding Piaget's processing levels, and using Vygotsky's theory, remain cognisant of how children respond to the activities. Both Piaget's and Vygotsy's theories remain universally relevant. Hebe (2017), who agrees that both Piaget and Vygotsky have contributed enormously to the field of education through their theories of cognitive development, asserts that "there seems to be a dearth of scholarly work that brings to light the applicability of these theories in the integration of Environmental Education (EE) in the realm of Early Childhood Education (ECE)".

2.6.2. Stages of a '*Let's Think!*' lesson

Each *Let's Think!* lesson in the programme includes five pillars of cognitive acceleration.

1. The first one is *concrete preparation*, in which the materials and language of the lesson are introduced by the teacher. Using the correct mathematical language is imperative (Rudd et al., 2008; Ledibane, Kaiser, & Van der Walt, 2018; Robertson & Graven, 2020).
2. This leads to the second pillar of *cognitive conflict*, where some sort of stimulating challenge is presented that needs to be solved collaboratively.
3. The third pillar involves *social construction*. The children are encouraged to share their ideas and to communicate with each other in a respectful manner. The teacher needs to ensure that all the children's ideas are accepted and valued, and that emphasis is placed on the process rather than the solution. The children themselves then refine their ideas and try to draw conclusions. Throughout this process, the role of the teacher is paramount and moves from teaching to mediating or facilitating. All children need to be encouraged to participate and to justify their ideas. They are also guided towards evaluating the responses of others, leading to the creation of their own solutions. It is vital here that the teacher does not resolve the challenge for the children.
4. The penultimate pillar is *metacognition*, which takes place at the end of the lesson and involves the children analysing the way in which they approached the conflict and reflecting on their thinking processes.
5. The final pillar is that of bridging, where the children are encouraged to apply their knowledge to similar situations.

2.7. Debates on the effectiveness of a '*Let's Think!*' lesson on the understanding of concepts among learners

There is a much larger body of research on cognitive acceleration in the early years than on cognitive dissonance, and there are two schools of thought on the effectiveness thereof. It seems that, from the available literature, the cognitive dissonance approach is not commonly used in teaching math concepts to young children, as there is a belief that it is more relevant to adult learners and their attitudes, beliefs, and behaviours. It appears that a modified version of the cognitive dissonance approach can be used by presenting conflicts or discrepancies between what children think they know and what they learn and helping them to resolve these conflicts.

Another stance is that cognitive acceleration has a negative impact, and the results cannot be seen until later years. However, most studies have shown the benefits of cognitive acceleration programmes**,** as indicated in the literature below. The *Let's Think!* programme came about from the *Cognitive Acceleration through Science Education (CASE)* programme. CASE was trialled in nine schools in the UK, and the evaluation showed that the children made cognitive gains (Adey, Robertson & Venville, 2001, p. 6), and from this research it showed that even a few years later, the children who had been exposed to CASE were achieving higher grades than those who were not. This was the case for science, but it also had positive effects on mathematics and English (Adey et al., 2001, p. 6). With the encouraging outcomes of CASE, the researchers began to look at the impact of cognitive acceleration activities on younger children. In 1999, a preliminary appraisal of the materials for *Let's Think!* was implemented in 14 schools in London, and both qualitative and quantitative methods were used to track the efficacy of the programme. The results were that the children who participated in *Let's Think!* made significantly greater gains cognitively, than the control groups (Adey et al., 2001, p. 7). They later published a paper, "Effects of a cognitive acceleration programme on Year 1 pupils", in which their sample consisted of about 300 children in the experimental group and 170 children in their control group (Adey, Robertson & Venville, 2002). They concluded that a cognitive intervention programme "can have a significant immediate effect on the rate of children's cognitive development" (Adey et al. 2002, p. 23).

In 2010, Shayer and Adhami published a paper on "Realizing the cognitive potential of children 5–7 with a Mathematics focus: Post-test and long-term effects of a 2-year intervention", showing positive results on both cognition and professional development in teachers. They reported that this impact did not dissipate over time.

In another study done on Year 1 children in three different schools in the United Kingdom, Robertson (2014) showed that cognitive acceleration improved children's ability to share their ideas and made them more aware of their learning. It also stated that teachers changed their pedagogies and provided more opportunities for focusing on metacognition. Similarly, Venville and Oliver (2015, p. 48) found that teachers developed better teaching strategies, enabling students to participate in metacognition and social construction. A study carried out in Germany by Börnert-Ringleb and Wilbert (2015), looked particularly into working with children with disabilities. While their focus was on using thinking-aloud interviews, the students were solving Piagetian tasks, and problem-solving strategies were identified. Jordan and Brownlee (1981) explored the correlation between Piagetian programmes and school achievement tests and found that Piagetian tests had a stronger association with achievement than with intelligence tests. Professor John Hattie, an education researcher from New Zealand, and author of “Visible Learning”, ranked 252 influences related to learning outcomes. Piagetian programmes rated sixth out of these influences (Hattie, 2009, p.43) based on his meta-studies.

The most recent study I could find on the effects of cognitive acceleration was that of Seleznyov, Adhami, Black, Hodgen and Twiss (2022), which found that the cognitive acceleration programme also had a positive impact on teacher confidence and practice at the classroom level. It also corroborated the evidence from the original cognitive acceleration studies, including Shayer (2003), Adhami (2002), Adey, Robertson and Venville (2002), Oliver, Venville and Adey (2012), Robertson (2014) and Shayer and Adhami (2010). These research papers confirmed that “classroom collaborative work on reasoning has an impact on conceptual understanding and numerical proficiency” (2022:574). Despite the shorter duration of the intervention, it still confirmed that the upshot was a mean gain equivalent to 2.6 months of learning for the students. In addition to this, it indicated increased teacher efficacy, improved teaching practice and enhanced teacher confidence.

From the reviewed studies, there seemed to be consensus on the findings that the cognitive acceleration method has been very effective in enhancing the understanding of concepts among learners, and most of the studies have been carried out in western and developed nations. Thus far, the success of CAME has been documented in Hong Kong, Ireland, Nigeria, Singapore, and Finland (Finau, 2018). However, no studies have been found in the South African context, and this is the research gap that the present study sought to fill.

2.8. Theoretical framework

This study was guided by three theories, namely, Piaget's theory of cognitive development, Vygotsky's social cultural theory, and the social disability model. "Cognitive perspectives are helpful in focusing on individual learners, while sociocultural perspectives are appropriate when focusing on … pedagogy" (Dunphy et al. 2014, p.56). The three theories are discussed as follows:

2.8.1. Piaget's theory of cognitive development

Piaget is renowned for his theory on cognitive development in children, and it has strongly influenced educational practice (Börnert-Ringleb & Wilbert, 2015). Dunphy et al. (2014) agree that during the 1970s and 1980s, his influence on mathematics education in particular, was significant. "The pedagogy of cognitive acceleration is largely based on Jean Piaget's theory of cognition and his constructivist theory of epistemology (Millar, Venville & Oliver, 2014, p. 1).

Piaget's views are that learning is a process of discovery, and that knowledge is the product of active thought (Gordon & Browne, 2017, p.381). He also placed emphasis on the child's active role and that "biology and the environment play reciprocal roles in developmental change" (Cole & Cole, 2001, p.36). Simply put, the main premise of Piaget's cognitive theory is that as people experience the world, "they take in new information and either absorb it into what they already know (assimilation) or create a new place for it (accommodation), thus returning to a sense of balance (equilibration)" (Gordon et al., 2017, p.110). There is a link between children mastering Piagetian tasks while in the concrete-operational stage and their levels of school achievement and learning success, particularly in mathematics and reading skills (Jordan et al., 1981; Arlin, 1981). Children with learning disabilities show limited problem-solving abilities, and the competency to transfer these to different tasks, and there is a link between mastering Piagetian tasks and the prevention of learning disabilities (Börnert-Ringleb et al., 2015).

Piaget identified four major stages of cognitive development: the sensorimotor stage (0 to 2 years), the preoperational stage (2 to 6 or 7 years), followed by the concrete operational stage (6 to 12 years), and finally the formal operational stage (12 years to

adulthood). According to Piaget's stages, Grade R children fall within the preoperational stage, with some transitioning to the concrete operational stage, and this is the progression that the *Let's Think*! programme aspires to accelerate.
According to Carrol and McCullough (2018, p.56), in the late preoperational stage (ages 4–7), children are able to consider only one variable at a time, which is called "centring" in the Piagetian framework. In the concrete operational stage, children are able to consider two or more variables.

2.8.2. Vygotsky's Sociocultural Theory

According to Gordon et al. (2017), Vygotsky's theory focuses on "how values, beliefs, skills, and traditions are transmitted to the next generation" (p.116), and his belief was that family and social interaction are the primary influences in children's lives. Vygotsky's opinion was that the development of children is culturally specific, and that culture is passed on through imitation, instruction, and collaborative learning (Gordon et al., 2017). Language and collaboration in learning were prominent in Vygotsky's theory, rather than the relationship between development and learning (Moll, Bradbury, & Winkler, 2002). His theory also argues that, from the beginning, learning is socially mediated (Dunphy et al., 2014, p.44). The concepts that underpin the sociocultural theory are the zone of proximal development (ZPD), scaffolding and private speech.

Walshaw (2017, p.307) declares that "a Vygotskian approach to classroom activity that focuses on societal relations and activity can enrich our understanding of mathematical development". In the *Let's Think!* lessons, a considerable amount of learning takes place in group work, and the teacher plays a significant role in managing the process (Adey et al., 2001, p.3). Although not mentioned by Adey et al., this theory is also supported by Bruner's view of a proactive teaching role, in which the teacher needs to create a ZPD, provide scaffolding, and co-construct meaning with the child taking the child's perspective into account (Bruner, 1996). Carroll and McCulloch (2018, p.59) say it succinctly; "Pupils come to understand through collaborative social engagement," and they go on to say that problem-solving activities create co-construction, and learning occurs in this manner. This programme also applies Vygotsky's theory of the zone of proximal development (ZPD), which refers to the gap between a child’s independent ability and what they can achieve with the assistance of an adult or a ‘more experienced other’ (Vygotsky, 1978).

In terms of learning disabilities, the social constructionist view, led by Vygotsky, highlights the importance of prioritising the strengthening and empowerment of learners’ individual skills, instead of emphasising what they cannot do (Rodina, 2006; Trent, Article & Englert, 1998). Vygotsky’s view is that primary disorders lead to secondary disorders because the child may be excluded from society as well as traditional education. He also explains that applying social constructivism to mathematics means emphasising problem solving, and having learners create their own strategies to solve these problems by interacting with each other. Mabena et al. (2021) believe that this is how South African teachers should be expected to teach, being active in their roles as mediators, facilitators, and supporters of learning. “As facilitators, they should always view learners as active participants in the learning process” (2021, p.454), supporting those with barriers to learning.

Vygotsky’s postulation is that primary deficits are less able to be remediated, but secondary disabilities can be prevented through the correct teaching approach, mainly the positive resource approach (Rodina, 2006). According to Mallory and New, including children with physical or developmental differences in group work provides all learners “with opportunities to solve real problems and contribute to the making of new rituals, strategies, and concepts” (1994, p.327).

2.8.3. Social disability model

The term ‘social model of disability’ was first coined by Mike Oliver, a disabled academic, in the early 1980s. He was instrumental in demonstrating how barriers did not exist in the individual, but rather in society itself. Emerson and Holroyd saw his model as fostering “choice, empowerment and opportunities for maximising one’s potential” (2019, p. 1349). In the social model of disability, a disability is seen in terms of environmental, structural, and attitudinal barriers, which could be changed by minimising or removing them. This essentially means that the ‘deficit’ no longer lies within the person, but within the environment. “The social model is rooted firmly in the human rights paradigm, arguing for inclusion and the removal of all barriers that hinder the full participation of individuals with disability" (Donuhue et al., 2014, p.4).

Greene (2008) contended that by diagnosing a child under the medical model, the insinuation is that "problems reside within the child, and it is the child who needs to be fixed''. This raised the attention of critics who believed that it was society itself that contributed to these negative consequences, and perhaps it was not the responsibility of the disabled person to adjust to society, but quite the opposite – that society itself should change (Rieser & Mason, 1992). Disabled people and parents' groups started advocating for changes to the model to make it more inclusive. This was not simply a linear progression but represented a fundamental paradigm shift (Slee & Allan, 2001). The inclusion/exclusion debate was initially called the integration/segregation debate (Oliver & Barnes, 2010). The term 'inclusive education' became widely spread after the United Nations Salamanca Statement was signed in 1994 by 192 countries, and this document promoted education for all (Messiou, 2017). The social model was then developed with input from people with disabilities and in reaction to the limitations, negativity, and strong contrasts of the medical deficit model. The social model's underlying premise was that "people were not disabled by the functional limitations of their impairments but by the external barriers that prevented their full participation in the societies in which they lived" (Oliver et al., 2010). Watermeyer, Swartz, Lorenzo, Schneider, and Priestly state that "Disability can no longer be seen as a static feature of an individual but rather as a dynamic and changing experience determined by the changing nature of the environment" (2011, p.8).

2.8.4 Justification of the theoretical framework for this study

The three theoretical frameworks discussed were integral to this study. First, Piaget's theory of cognitive development was significant for three reasons because of the relevance of the preoperational and concrete operational stages of development in determining what Grade R children should and are capable of in terms of thinking skills. Secondly, from Piaget's theory, we used the premise that thinking involves assimilation, accommodation, and equilibration. Finally, we used these concepts to promote cognitive acceleration by purposefully creating cognitive conflict.

“Mathematical development, in Vygotskian understanding, is conceptualised as a process involving participation, communication, inclusiveness, interactiveness, collaboration, situatedness, and so forth” (Walshaw, 2017). Vygotsky’s sociocultural theory is pivotal in creating opportunities for the Grade R children to learn from each other. The views on learning as an interactive process whereby children learn from the teacher and from each other through a process of expressing ideas and through discussion formed the basis for the small group work in *Let’s Think!* lessons. The role of language and social construction is also essential. Dunphy et al. (2014, p.44) state that two essential contexts in which learning occurs are shared activities and shared talk. In the groups, the teacher presented some sort of cognitive conflict and then encouraged the sharing of ideas and thoughts among the children by asking guiding questions. As the groups were carefully engineered according to cognitive abilities, the conviction was that the children should be able to solve the conflict and would then be learning from each other based on ZPD, scaffolding, and Vygotsky’s concept of the ‘more knowledgeable other’. In Mutekwe’s study (2018) on the effectiveness of using this approach in teaching and learning in the classroom in Gauteng, he found that equitable learning can be fostered in the classroom by using mediated learning experiences within the children’s ZPDs, using material, psychological, and semiotic learning tools as well.

The social model of disability also informed this study because the *Let’s Think!* lessons are designed in such a way that they are accessible to all children in a mainstream class, regardless of any challenges they may be experiencing. This allows children to learn in a way that supports them without written work, or the stress of performing academically in front of others. The small, manageable groups also make it easier for the teacher to support children in a hands-on way. This method of inclusion is supported by the social disability model.

2.9. Conclusion of the Chapter

This chapter focused on the literature review related to teaching a *Let’s Think!* lesson, as well as the theoretical frameworks the study is based on and the justification thereof. The next chapter discusses the choice of research design and methodology for this study.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

This chapter presents the research design and methodology of the study. This includes the research paradigm, research design, research methodology, information regarding the research site and sampling, as well as the data collection methods used. This is followed by a discussion on the trustworthiness, validity, and reliability of the research instruments. The choice of data analysis is considered, as well as the ethical considerations of this study.

3.2. Research Paradigm

A paradigm "serves to define what should be studied, what questions should be asked, how they should be asked, and what rules should be followed in interpreting the answer obtained" (Ritzer, 1991, p.120), and can be seen as a worldview. Mertens (2009) identifies four fundamental belief systems that must be considered when defining a paradigm, which include axiology (values and ethics), ontology (the nature of reality), epistemology (the validity of knowledge) and methodology (approaches to investigation). Ritzer (1991) views paradigms as perspectives that cannot be classified as true or false, while Paul and Ward (1996) contend that paradigms are a matter of choice based on inclination, and that the debate about inclusion is rooted in paradigms rather than scientific issues.

This study was based on the pragmatic paradigm, which means the researcher used both qualitative and quantitative methods to collect and analyse the necessary data in order for the research problem to be optimally understood (Cresswell & Cresswell, 2018, p.48). The view of Kaushik and Walsh (2019) is that people's perceptions are influenced by social experiences, and knowledge is therefore unique to each person; this is a major foundation of pragmatic epistemology. The pragmatic research paradigm was relevant for this study because the quantitative phase involved the use of both pre- and post-test scores to ascertain the effectiveness of the intervention that was adopted among learners. The qualitative phase, on the other hand, involved observing learners during the lesson to determine how assimilation occurred.

3.3. Research Design

Within the mixed methods paradigm, the study adopted the concurrent triangulation research design. The purpose of this design is to use both qualitative and quantitative data which is collected at the same time, in a single study (Castro, Kellison, Boyd & Kopak, 2010). It basically involves a separate collection of both kinds of data that run concurrently, and this supports the researcher in how to best understand the research problem. The concurrent triangulation design was chosen because I wanted to validate the quantitative results with the qualitative data. In this study, the quantitative data was collected through observation and using pre- and post-tests. The two *Let's Think*! Lessons were recorded and the qualitative data was taken from observation of the recordings and during the lessons. This method added a depth and scope of findings to this study as it allowed me to observe the learning of the boys and gather quantitative data at the same time.

3.4. Research Methodology

The study adopted a mixed methods research methodology in its investigation. This involved the use of both quantitative and qualitative research methods. Qualitative research involves the interpretation of subjective meaning (Fossey, Harvey, McDermott, & Davidson, 2002), not numerical data. The process of qualitative research "involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data" (Cresswell et al., 2018, p. 41). On the other hand, quantitative research is a "process that is systematic and objective in its ways of using numerical data from only a selected subgroup of a universe to generalise the findings to the universe that is being studied" (Maree, 2016, p.162). Quantitative data collection includes methods like surveys, polls, checklists, and sample groups.

The mixed methods research methodology was appropriate for this study because the research purpose and research questions required both quantitative and qualitative data. According to Andrew and Halcomb (2009, p.37), "the strength of mixed methods designs is to balance flexibility of qualitative exploration with the fixed characteristics of theoretical grounding and hypothesis-testing inherent to many quantitative approaches".

3.5. Research Site

The research took place at a private, mainstream, monastic primary school for boys located in the City of Tshwane Metropolitan Municipality near Brooklyn, Gauteng, South Africa. The school runs from Grade 000 to Grade 7, which in the South African context is from age three to 13 and is the only private primary school to offer boarding in Pretoria. There are just over 400 learners and over 90 staff members. As an independent school that receives no support from the government in the form of subsidies, it is a member of the Independent School's Association of South Africa (ISASA). The school receives income solely from tuition and boarding fees, and according to the school bursar, has an annual operational budget of R60 000 000. The school's resources include 30 classrooms, two swimming pools, two sports fields, four tennis courts, one school theatre, two libraries, one laboratory, and one boarding house.

The school is an association of persons that was set up to run as a non-profit association. The school is governed by its Constitution and the School Council which is set up and managed in line with the provisions made in the School Constitution. The School Council consists of 24 members, which include parents, Old Boys, trust representatives, current management staff, as well as educational, business, and religious specialists. The operational management of the school is done by the school management which is a 13-person team and includes Heads of Department from each department in the school.

Brooklyn is a well-established and wealthy suburb of Pretoria, and most of the children come from affluent socio-economic backgrounds. In market research conducted by the school, it was determined that to be able to afford this school, a person would need to be in the top 5% of earners in South Africa.The safety of learners in the school is of utmost importance and the school is equipped with alarm systems, beams, and electric fences all around an enclosed area of the campus, with security guards 24/7.

The Grade R section of the school has its own enclosed area and consists of two classrooms, a shared playroom, two playgrounds and a kitchen. There are two teachers and two interns for 48 boys. Diagnosed ADHD, speech difficulties, language barriers, developmental delays, occupational therapy needs, and play therapy needs are among the challenges that the boys face.

3.6. Research Sampling

Use was made of simple random sampling. In this sampling method, "all the individuals have an equal opportunity to participate in the study where the selection process is entirely based on luck" (Noor, Tajik & Golzer. (2022, p. 78). However, in this case, the opportunity was provided for 48 Grade R boys in two classes, and only the boys whose parents returned the consent forms were allowed to participate. Only 18 learners returned their permission forms. This resulted in eight boys in the control group who came from one Grade R class, and ten boys in the experimental group, who came from the other Grade R class.

The children in one class were not exposed to the lesson, and the children in the other class participated in a *Let's Think!* Lesson, thereby making the first class a control group. The reason for choosing this specific school was because I worked there until March 2022. I chose one particular class for the intervention group because that is the class I taught, I knew the boys, and I was aware of their abilities and challenges. The control group consisted of boys from the other class, who had returned the consent forms, but I did not teach them and therefore did not know them as well. For this study to be effective, the boys needed to be familiar with the facilitator in terms of feeling confident to participate and to communicate during the lesson, as well as with the pre- and post-tests.

The boys had previously been exposed to other *Let's Think!* Lessons that I had implemented in early 2022. The lessons took place inside the classroom, while the others were participating in outside play. The reason for this is so that the boys who were not part of the lesson would not be exposed to the challenge before their turn. The intervention timeframe was short, as one lesson took place straight after the other on the same day, ensuring limited interaction between the two groups.

3.7. Data Collection Methods

Two methods of data collection were implemented in the form of pre- and post-tests, and observation schedules.

3.7.1. Pre and post tests

For this study, use was made of both pre- and post-tests to identify the classification abilities of the boys, and particular focus was paid to the boys who experienced challenges. Both tests consisted of the same three questions, and a checklist comprised of seven columns, the first for the number of the child (to maintain anonymity), then the age of the child, three columns for the sorting category that each child used, the sixth column identified whether or not each child could classify two ways at the same time, and the seventh column was for the mark out of five. For the mark allocation, one mark was avoided per sorting category that each child was able to do, with two marks allocated for classifying two ways at the same time.

3.7.1.1 Pre-tests

To find out if the boys were familiar with double classification, a pre-test was done for each boy individually before the lessons. A set of dinosaurs was used, and three questions were asked:

- Could you please sort these dinosaurs for me?
- Could you sort them for me in a different way now?
- Do you think you can sort them in two ways at the same time?

Figure 1: Selection of dinosaurs used for pre-test classification

3.7.7.2 Post-tests

Four weeks after the intervention took place, a post-test was carried out. This test was identical to the pre-test, except a set of transportation toys was used. The following questions were asked:

- Could you please sort these transport vehicles for me?
- Could you sort them for me in a different way now?
- Do you think you can sort them in two ways at the same time?

Figure 2: Selection of transport vehicles used for post-test classification

The differences between the pre- and post-test scores indicated whether the LTP intervention was effective or not.

3.7.2. Participant observation

"Observations can provide educators with the data to write rich narrative assessments of children's mathematical learning" (Dunphy et al., 2014, p. 100). The boys doing *Let's Think!* Lessons were filmed as to gain qualitative data regarding their understanding. There were two lessons with groups of five children at a time. I was then able to view the videos later to see the involvement of each child and take notes on my observations, again with a focus on those who experience challenges in the classroom.

3.8 Data Collection Procedure

I started working with the intervention class in January and left the school at the end of March. Following that, I received permission from the WITS School of Education Research Ethics Committee, the Department of Education in Gauteng, and the headmaster of the school to carry out my research with my previous class. A letter was then sent to all Grade R parents explaining the study and asking for consent. Once informed consent was obtained by the parents, I then asked the boys for their assent.

A pre-test was carried out with each boy who agreed to be part of the study. The time taken for the pre-test was between 5 and fifteen minutes each. I also made observation notes during the pre-test as part of my qualitative data. After all boys had completed the pre-tests, I then divided the intervention boys into two specific groups according to a combination of abilities. Once the groups were established, both *Let's Think!* lessons were carried out in one day, each one being 30 minutes long. These lessons were recorded with the permission of both parents and boys, and the quantitative data was taken from here. Four weeks later, the post-tests were carried out over a period of three days. Again, each test took between 5 and fifteen minutes over a period of three days, and I also took observation notes during this time.

3.9. Trustworthiness/ Validity/ Reliability of research instruments

Trustworthiness involves others finding the results of the study interesting, taking the truth, applicability, consistency, and neutrality into account. For trustworthiness to be determined, confirmability and dependability must be assessed (Lincoln & Guba, 1985, p.323). To ensure that the study is trustworthy, valid, and reliable, it is necessary to look at each method and then discuss the four criteria of credibility, dependability, transferability, and confirmability. First, the validity and reliability of quantitative data are discussed as follows.

3.9.1. Validity of pre- and post-tests

This can be internal or external. Internal validity is the "extent to which variations in an outcome variable can be attributed to controlled variation in an independent variable" (p. 290). External validity involves these variations being generalised. The validity of the tests was ensured by using the expert judgement of the research supervisor, who ascertained that the tools were valid.

3.9.2. Reliability of pre- and post-tests

This means that the same results will be consistent if they are repeated or replicated. The reliability of the tests was ensured by the use of Cronbach's Alpha, which is a measure of internal consistency, that is, how closely related a set of items are as a group. In this study, the reliability of data was tested using split-half analysis. Pallant (2000) affirms that split-half reliability is a statistical method used to measure the consistency of the scores of a test. It is a form of internal consistency reliability and is commonly used as a measure of reliability for quantitative data. "Split-half reliability is a convenient alternative to other forms of reliability, including test–retest reliability and parallel forms of reliability because it requires only one administration of the test" (Bonett, 2008). The method involved splitting the data into halves and correlating scores on the two halves of the test. The resulting correlation was then adjusted for test length using the Spearman-Brown prediction formula. George and Mallery (2003) classify reliability coefficient values as: >.8 = Excellent; > .7 = Very Good; > .6 = Good; > .5 = Acceptable; and < .5 =Weak. Similarly, Oso and Onen (2011) hold the view that a data set has good reliability if the split-half coefficient is above 0.6. The split-half reliability coefficient values are reported in Table 1.

Table 1: Reliability Statistics

Correlation Between Forms		.653
Spearman-Brown Coefficient	Equal Length	.812

Unequal Length	.812
Guttmann Split-Half Coefficient	.738

Source: Author (2022), SPSS Analysis.

Table 1 shows that the Spearman-Brown coefficient (0.812) and Guttman Split-Half coefficient (0.738) were found to be high in the split-test reliability analyses of classification ability among Grade R learners. These findings indicated that the data had an acceptable and reliable scale. This is in line with the recommendation by Oso and Onen (2011) that a coefficient of at least 0.60 is of adequate reliability, implying that the data had an acceptable and reliability standard.

3.8.3. Credibility of qualitative data

Credibility means that confidence can be placed in the findings of the study. In this study, credibility of data was ensured by prolonged engagement. “If prolonged engagement provides scope, persistent observation provides depth” (Lincoln et al., 1985, p.304). Moreover, credibility was ensured by triangulation because a single method can never adequately shed light on a phenomenon. Using multiple methods helped facilitate a deeper understanding.

3.8.4. Transferability of qualitative data

This is the ability of the study to be transferred to other contexts or in other settings and it took place through a thick description, which is a way of achieving external validity. The widest possible range of information should be included in the thick description (Lincoln et al., 1985, p.316). The use of a detailed description of data from the observation method ensured data transferability in this study.

3.8.5. Dependability of qualitative data

Dependability is the absence of errors made by the researcher in terms of collecting, analysing, and reporting the results of the study, and this takes place through an inquiry audit. The auditor would look at both the process and the product (Lincoln et al., 1985, p. 318). In the present study, the researcher used an audit trail to ensure the dependability of the data from observation.

3.8.6. Confirmability of qualitative data

Confirmability determines whether "the data and interpretations of the study are grounded in events rather than the inquirer's personal constructions" (Lincoln et al., 1985, p. 324), which means that a degree of neutrality should be present, and researcher bias should not be evident. In the present study, confirmability was ensured by audit, audit trail, triangulation, or reflexivity.

3.9. Data Analysis

The processing of raw data in order to answer research questions is referred to as data analysis. Data was analysed quantitatively and qualitatively, as discussed below.

3.9.1. Quantitative data analysis

Once the raw data had been collected, the quantitative data analysis started with descriptive statistics. This is a "collective name for a number of statistical methods that are used to organise and summarise data in a meaningful way…and serve to enhance the understanding of the properties of the data" (Field, 2013 in Maree, 2016, p.204). The pre- and post-tests were compared through the use of descriptive statistics, such as frequencies and percentages. Moreover, means of pre- and post-tests were also obtained. Finally, the effectiveness of the intervention was ascertained by using a dependent samples t-test and comparing the pre- and post-test scores for each learner in both the control and intervention groups. Additionally, the independent samples t-test was used to compare the pre and post tests for the control and intervention groups.

3.9.2. Qualitative data analysis

Braun and Clark (2006, p. 77) describe thematic analysis as "an accessible and theoretically flexible approach" for analysing data from observations, and that it "provides a flexible and useful research tool, which can potentially provide a rich and detailed, yet complex account of data" (2006, p.82). In their opinion, "it minimally organises and describes your data set in rich detail" (2006, p. 79). Braun and Clarke's six phases of analysis were followed for this research.

Firstly, I had to first become acquainted with the data, which entailed transcribing data from participant observation in the intervention group, as well as watching the recorded lessons many times, looking for meaningful interactions, patterns, and potential coding possibilities. Secondly, I identified potential patterns by colour coding the transcriptions and then generated an initial list of emerging ideas. From there, I generated initial codes involving the collated data according to sets. At this point, many potential themes began to surface. Once all the data was coded and collated, I needed to see which sections overlapped, and I began to focus on analysing and identifying broader themes as well as sub-themes. For the fourth step, I created a spreadsheet in which I started matching my observations and part of the transcriptions to each theme and sub-theme. I reviewed and refined my themes and sub-themes and set aside the themes that were not relevant to my data set. Following much editing of themes, I was able to define and name my themes and sub-themes clearly, ensuring that I took my research questions into account to ensure relevance. Finally, the report was produced, after deliberating the underpinning assumptions and implications of the themes and ensuring that my interpretations of the data were consistent with my chosen theoretical framework.

3.10. Ethical considerations

The ethical considerations in this study involved obtaining permission from relevant authorities, informed assent, anonymity, and confidentiality, and each of them is discussed as follows:

3.10.1. Permission Letters

Permission was obtained from the WITS School of Education Research Ethics Committee, as well as from the Department of Education in Gauteng, and the principal of the school.

3.10.2. Informed consent and assent

Since Grade R learners are minors and were involved in this study, informed consent was obtained from the parents first to ensure that all boys had permission to participate, and then the boys needed to give their assent. A letter detailing the research, and what it would be used for was sent home and included the guarantee of confidentiality. Thereafter, parents who accepted their children’s participation in the study signed the informed assent forms. The boys were then asked orally and with the use of pictures whether they were willing to participate or not, and this indicated their assent. The group work took place during playtime, so those who did not grant their permission played outside, while five boys at a time worked inside.

3.10.3. Anonymity

Anonymity was guaranteed through the use of numbers instead of names for all boys. Although the lessons were filmed, they were for the use of the researcher only and were deleted on completion of the qualitative research. Therefore, in the tests and diagrams, no names of learners were included. Moreover, when using the videos to collect data, all learners’ faces were defaced to ensure that no one was able to identify them, which ensured anonymity.

3.10.4. Confidentiality

Confidentiality was maintained through the safeguarding of information and research throughout the research process. This included the storage and retention of information as well as the disposal of stored information once used. The results of this study were stored in a computer using a unique password that was known only to the researcher, and the data will be destroyed five years after the completion of the study.

3.11. Conclusion of the Chapter

This chapter presents the research design and methodology used for this study. It included detail on the data collection methods, tools, and instruments. The next chapter discusses the results and discussion of the qualitative and quantitative data analysis.

CHAPTER FOUR

FINDINGS OF THE STUDY

4.1. Introduction

This chapter presents the findings and interpretation of the study as indicated in the research methodology, using qualitative and quantitative data, and is divided into sections and subsections. The quantitative research findings are based on the research objectives and hypothesis. The experimental findings were presented using descriptive and inferential statistics. Descriptive statistics summarised the classification scores in the control and intervention groups, while inferential statistics tested the hypothesis and drew inferences. Statistical tests and Wilcoxon rank test analysis were used to compare the classification scores between the groups. All tests of significance were computed at $\alpha = 0.05$. The data analysis was performed using the Statistical Package for Social Sciences (SPSS) version 26.0.

Qualitative data was obtained from observations and note-taking during pre-test sessions before the *Let's Think*! lesson was implemented as the intervention, as well as during post-test sessions. Two videos of the intervention lessons were recorded. This study made use of Braun and Clarke's thematic analysis (2006). It required the transcription of the sorting sessions with the boys and of the two *Let's Think!* lessons. Following this, coding took place, and potential themes were identified. They were then reviewed, defined, and named, and then the write-up was done. The results are presented in line with the three research questions of the study, as presented below.

4.2. Purpose of the Study

The purpose of the study was to examine the effectiveness of using a '*Let's Think!*' lesson (a cognitive dissonance approach) to assist Grade R learners in one mainstream boys' primary school in Gauteng to classify objects.

4.2.1. Questions of the study

The study was guided by the following study questions:

a) How do the Grade R learners classify a group of objects before the implementation of the *Let's Think!* lesson (cognitive dissonance approach)?

b) How do the Grade R learners classify a group of objects after the implementation of the *Let's Think!* lesson (cognitive dissonance approach)?
c) Is the cognitive dissonance approach effective in enhancing the classification ability among Grade R learners?

4.2.2. Hypothesis of the Study

The study was guided by the following null hypothesis:

$H_0$1:. Cognitive dissonance approach is not effective in enhancing the classification ability among Grade R learners.

4.3. Questionnaire Return Rate

Table 2, which shows the summary of the return rate of questionnaires from the respondents, reveals that the return rate of the questionnaires was acceptable for the study.

Table 2: Questionnaire Return Rate

Respondents	Questionnaires administered	Questionnaires returned	Return rate (%)
Group 1- Experimental	24	10	41.7
Group 2 -Control	24	8	33.3
Total	48	18	37.5

Source: *Study data (2022)*

The study targeted a total of 48 Grade R learners, of whom 24 were in the intervention group and the other 24 were in the control group. Out of these numbers, a total of 18 of them comprising 10 experimental and 8 control learners actually took part in the study, translating to an overall response rate of 37.5%. This return rate was considered reasonable for an experimental study, as it is consistent with those obtained in similar studies, as observed by Jarvenpaa and Staples (2001) and Dennis (2003), who found that response rates usually hover around 30%. However, the response rate did not go beyond 50% because the study required the full consent of both parents and learners, which was not received in some cases.

4.4. Age of the Study Participants

The study sought to investigate the demographic characteristics of the learners who took part in the study. The background information was considered necessary to determine whether they were adequately representative in terms of their demographic characteristics to allow generalisation of the results of the study. The demographic information considered was the participants' age, which was considered the most basic demographic difference among the learners. Information on age was considered important to this research because it is anticipated that the effectiveness of the cognitive dissonance approach in enhancing classification ability among Grade R learners may vary given their age. Figure 3 shows a summary of the age distribution among the learners who took part in the study.

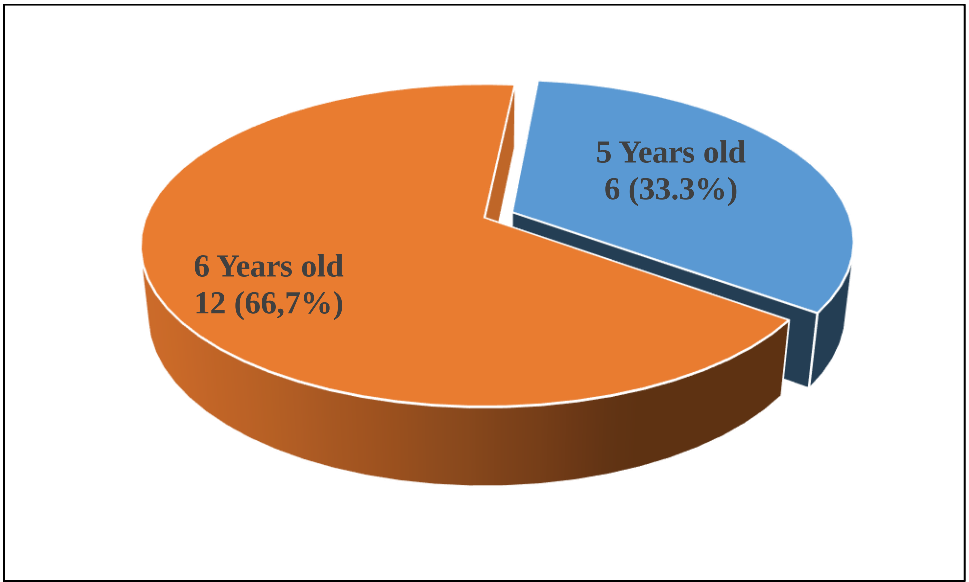


Figure 3: Age Distribution of the Learners (n=18)

Source: Study data (2022)

The findings of the study show that the learners who took part were either five or six years old. However, a significant majority of them were aged six years, as reflected by 66.7%. Those who were five years old only formed 33.3% of the learners who took part in the study. This was not surprising because the study targeted learners in Grade R, and generally, children at this level of learning in South Africa are mostly aged between five and six years. Grade R as a part of Early Years Education is the foundation phase of education, where learners are taught elementary skills on how to read, write, and speak in their own language and begin to learn another language. Grade R learners are where formal schooling starts, and they are either in the preoperational stage or transitioning to the concrete operational stage.

4.5. Classification of objects before the implementation of the *Let's Think!* Lesson (cognitive dissonance approach) by Grade R learners

The first objective of the study sought to assess how the Grade R learners classify a group of objects before the implementation of the *Let's Think!* Lesson using a cognitive dissonance approach. The study envisaged that classification and categorisation were an indicator of cognitive developmental achievement. Hence, the magnitude of being able to sort, classify, and categorise items is an indicator of cognitive development. This objective was addressed using both descriptive and inferential statistics.

4.5.1. Descriptive of Statistics of Pretest Classification Ability of the Study Participants

To find out if the boys were familiar with double classification, a pre-test was done for each boy individually before the treatment, that is, before the implementation of the *Let's Think!* lesson. The pretest information was expected to show if all groups had similar cognitive abilities, which was expected to be the case if random assignment was employed. The boys were presented with dinosaurs to sort and classify. This was to find out whether the boys were able to sort the dinosaurs accurately, then sort them in a different way, and then sort them in two ways at the same time. All the participants in both the intervention and control groups were pretested, and the findings were summarised separately.

4.5.1a Pretest Results among the Intervention Group

Figure 4 shows the classification of objects before the implementation in the intervention group.

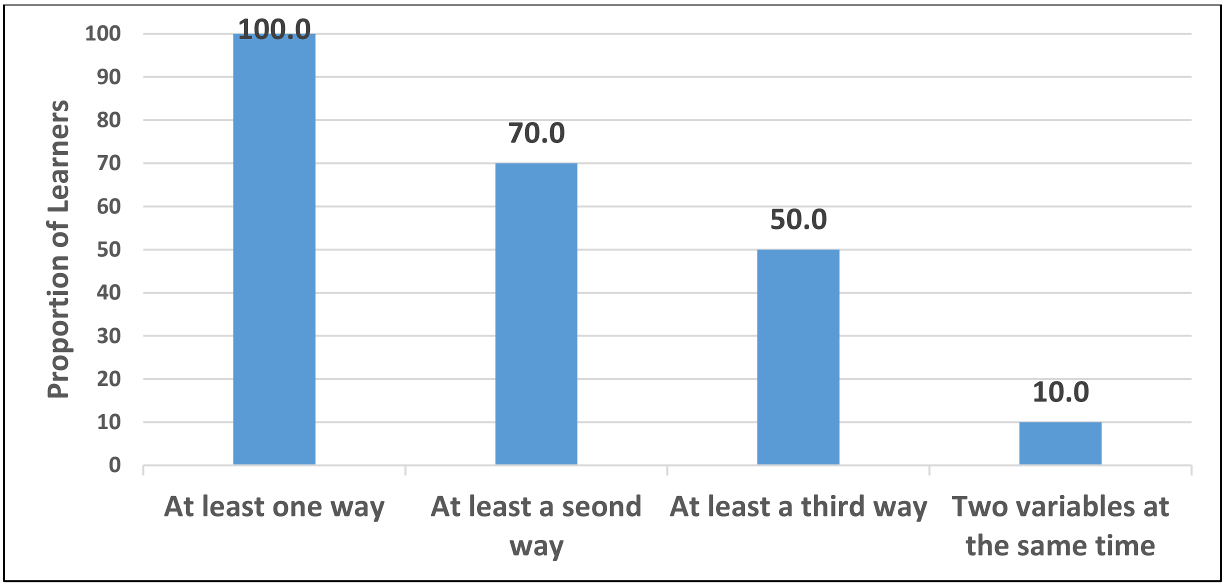


Figure 4: Intervention Group Pre-test Results

From the pretest results of the intervention group, it is evident that only half (50.0%) of the study participants in the intervention group were able to sort out the dinosaurs in at least a third way. This means that only one out of every two participants in the intervention group was able to sort out the dinosaurs using three different variables, suggesting that a comparatively small number of study participants in the intervention group was able to accurately sort the dinosaurs, sort them in different ways and sort them in two different ways at the same time. However, all the participants were able to classify the dinosaurs in at least one way, and 70.0% of the intervention group were able to sort the dinosaurs in two different ways. This group classified the dinosaurs according to their kinds, their colour, their legs, and whether or not they could fly.

In the course of sorting out, the colour of the dinosaurs was the most prevalent way of categorising them. In the first category, 80.0% of the intervention group participants used colour as a way of sorting out the dinosaurs. This was followed by the kind of the dinosaur, which was used by 20.0% of the study participants during first categorisation and 50.0% during the second categorisation at the pre-test stage. Other ways of classifying the dinosaurs, as used by the intervention group, included their diet, texture, legs, and being able to fly or not.

On their classification ability ratings, the results show that, on average, the overall rating on the ability to classify objects was 2.4 on a scale of 1 to 5 among the study participants in the intervention group. This suggests that their ability to sort the dinosaurs accurately in different ways and in two ways at the same time at the pre-test stage was generally low. In fact, 30.0% of the study participants in the intervention group had a rating of 1 out of 5, 20% had a rating of 2 out of 5, 40% had a rating of 3 out of 5 and only 10% were rated at 5 out of 5 in classification skills.

4.5.1b. Pre-test Results among the Control Group

With regards to the control group, Figure 5 shows the summary of pre-test results for the classification of objects before the implementation of the *Let's Think!* programme among the control group.

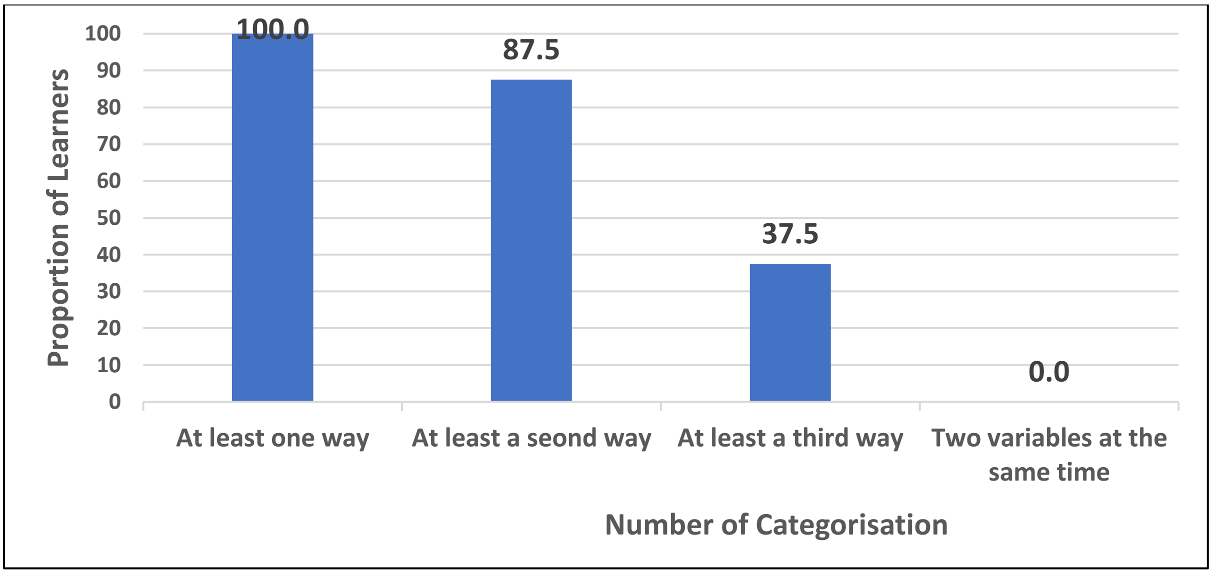


Figure 5: Control Group Pre-test Results

The pre-test results of the control group show that only three out of eight of the participants, translating to 37.5%, could classify the dinosaurs in a third way. This implies that only a few of the control group participants were able to sort the dinosaurs accurately in three different ways. However, seven out of eight, equivalent to 87.5% of the control group study participants, were able to classify the dinosaurs at least a second way at the pre-test stage.

On the other hand, it emerged that all of the control group participants were able to classify the dinosaurs at least in one way. This was reflected in the fact that eight out of eight (100.0%) of the participants classified the dinosaurs in at least one way. During the pre-test stage, the colour of the dinosaur was the most common way of classification among the learners in the control group, followed by the kind of dinosaur. Other ways of sorting them out that emerged, as used by the control group during the pretest stage, include their diet, features, and initial letters in their names.

In general, the results show that, on average, the overall ability rating to classify dinosaurs among the study participants in the control group was 2.4 on the scale of 1 to 5. This implies that their ability to sort the dinosaurs accurately in different ways at the pre-test stage was generally low. Further, the results reveal that 62.5% of the study participants in the control group had a rating of 2 out of 5 and 37.5% were rated at 3 out of 5 in classification skills.

4.5.2. Comparing Pre-test Classification Ability by Age of the Grade R Learners

The study sought to investigate the effect of age on learners' abilities to sort and classify objects. Given the nature of the data, the Mann-Whitney U-test, which is a non-parametric alternative to an independent samples t-test, was used to investigate the differences. Table 3 shows the results of the Mann-Whitney U-test and whether age affected pre-test results.

Table 3: Hypothesis Test Summary-Effect of Age on Pre-test Results

	Null Hypothesis	Test	Mann–Whitney *U*	Sig	Decision
1	The medians of Pretest Intervention Group are the same across categories of Age of Learner.	Independent-Samples Median Test	2.50	.074	Retain the null hypothesis.
2	The medians of Pretest Control Group are the same across categories of Age.	Independent-Samples Median Test	.686	.102	Retain the null hypothesis.

The age of the learners, which was the independent variable, was grouped into two, namely, five and six years. The dependent variables of the study were the pre-test results of the learners' classification score. Table 3 indicates that Mann-Whitney has established that the pre-test median scores of the learners' ability to sort and classify objects within the intervention group were not significantly different between the two ages of the learners. This was reflected by the fact that the distributions in the two age groups did not differ significantly (Mann–Whitney U = 2.50, P > 0.05 two-tailed). This finding means that the medians of the pre-test intervention group are the same across categories of learners' ages. It was therefore concluded that age has no effect on Grade R learners' ability to sort and classify objects during the pre-test stage.

4.5.3. Qualitative data analysis

Thematic analysis was used to analyse qualitative data. The themes, which emerged from the data include difficulty understanding instructions, negativity, and giving up.

Theme 1: *Difficulty understanding instructions on sorting*

According to CAPS, Grade R children should be able to sort or classify objects. In the present study, to assess the Grade R learners' understanding of the classification of objects, they were given tasks to perform with the knowledge they had before the intervention. Interview data was obtained from Grade R learners on how they understood the classification of objects. However, according to the data, the boys did not all understand the term, 'sort' and this information needed to be clarified. Most of the Grade R learners reported struggling with understanding how to classify, implying that they had difficulty performing the task. In the control group, six of the eight boys expressed their confusion, either by asking a question, or by interpreting the instruction incorrectly. The interview excerpts from six Grade R learners on their difficulty understanding sorting are reported as follows:

C12: "So we put all the blue dinosaurs to the blue dinosaurs? Maybe yes, I could put all of them in the same way, all the purples…or can I?"

C13: "I would make it the same colours again, because I don't know different ones."

C16: "Let's play a game and put them in a pile. No, I don't know what. No. I think I know. A game."

C17: He started to sort according to type, then with colours and then got confused.

C18: "Like colour? I'll check at the end who has the most dinosaurs and if it's a tie, it'll be my favourite colour. Now I need to close my eyes and pick. Blue."

C19: "I don't know. I still don't know."

The results indicated that the Grade R learners in the intervention group also reported difficulties and challenges in performing the classification task that they were assigned. According to the results obtained prior to the intervention, the Grade R students appeared to have limited knowledge of object sorting. In the intervention group, seven boys expressed challenges and difficulty in a similar way to the control group. The interview excerpts from Grade R learners in intervention group on this theme are reported as follows:

C1: "Must I order them? Let's make all the colours in lines."

C3: "So must I put them all in order?"

C4: He sorted colour again, then made a pattern, then sorted colour again, then a pattern.

C6: "In rows? I have no idea. What should I do? What should I do? What should I do? What should I do? What should I do? What should I do?"

C8: "You mean in colours? Just give me some time. Some patterns?"

C10: "In the same colour?"

C11: "Like in 5 rows?"

The qualitative results obtained from the pre-test data from both the control and intervention groups revealed that 13 out of the 18 Grade R learners struggled with the sorting and classification task that was assigned to them, due to a lack of understanding the mathematical language. Therefore, it can be argued that Grade R learners had a limited understanding of the classification task based on the knowledge they had before any intervention was implemented.

Theme 2: *Negativity and giving up*

Gray's research (1987) showed that negative emotions are connected to avoidance motivation. This indicates that when faced with a challenge that is deemed too difficult, children will opt out. This is backed up by the research of Määttä (2015, p.30), who found that when children struggle with a task, "motivation determines whether they give up or embrace the challenge and persist to overcome it". Out of the 18 boys observed during the pre-test, 17 of them could independently sort according to colour, and 14 of them independently sorted by kind. However, they began to express their concerns when asked to classify a third way or to sort according to two variables at the same time. Most of the Grade R learners reported doubt in their capabilities of attempting the task on the classification of objects. This was evident in what they said when asked to complete the task by the facilitator as reported below:

C1: "I can't think about that one."

C3: "I don't really know how to do another way."

C4: "This is too tricky. Enough."

C7: "I've had enough."

C8: "I actually don't know. I can't think about it anymore because there's none else."

C9: "That seems too tricky. Er, I think I want to go now."

C10: "This is my last one. I'm done."

C11: "I don't know how to do it differently. That was too hard!"

Interestingly, there were eight boys who claimed the task was too difficult in the intervention group and seven boys in the control group.

C12: "That's going to be hard"

C13: "I can't"

C14: "Too tricky"

C15: "I can't do what I'm trying to do right now. It's too hard"

C16: "It's too difficult to what I thought. No, I don't know what. No. Oh My God"

C17: "I'm feeling tired. I've had enough."

C19: "I don't know. I still don't know. I'm thinking some more. I think I'm done."

From the qualitative results presented above, it is evident that most Grade R learners viewed themselves as incapable of sorting the objects in more than two ways before the intervention. The learners also indicated challenges with comprehending how to carry out the tasks. This implies that the learners were struggling with the classification of objects in the classrooms.

4.6. Classification of objects after the implementation of the *Let's Think!* lesson by Grade R learners

The second objective of the study sought to assess how the Grade R learners classify a group of objects after the implementation of the *Let's Think!* lesson using a cognitive dissonance approach. After the pre-test was conducted with the two groups, a *Let's Think!* lesson was taught to one class (the intervention group). This was followed by a post-test four weeks later for both groups, as the use of a pre-test-post-test for the two groups was expected to solve the problem of maturation, which is the effect of time (between the pre-test and the post-test) on study participants that would have influenced the outcome. It was envisaged that participants would be exposed to maturation both in the intervention group and the control group; therefore, any difference between the outcomes of these two groups would be considered an effect of the treatment alone and not the effect of maturation. Likewise, this method was expected to eliminate the effect of recall, given that it affected both the intervention and the control group, and any difference between the outcomes of these groups would be considered the effect of the intervention alone. Equally, it was imagined that pretesting would have an effect on post-test results; thus, the presence of a control group during the post-test protects against testing effects, as these would affect both groups, and therefore any difference between the outcomes of these groups would be due to the effect of the intervention action alone.

To investigate how the Grade R learners classify a group of objects after the implementation of the *Let's Think!* lesson (cognitive dissonance approach), descriptive statistics were employed to explore the distribution of post-test scores, and inferential statistics investigated the effect of age on post-test scores.

4.6.1. Descriptive Statistics of Study Participants' Post-Test Classification Ability

After four weeks, the two groups (intervention and control) were both presented with transport vehicles to sort and classify. This was to find out the effect of the *Let's Think!* lesson on Grade R learners. The effect of the programme would be inferred from the learners' ability to sort out the transport vehicles accurately in different ways and in two ways at the same time.

4.6.1a. Post-test Results among the Intervention Group

Figure 6 shows the summary of post-test results for the intervention group.

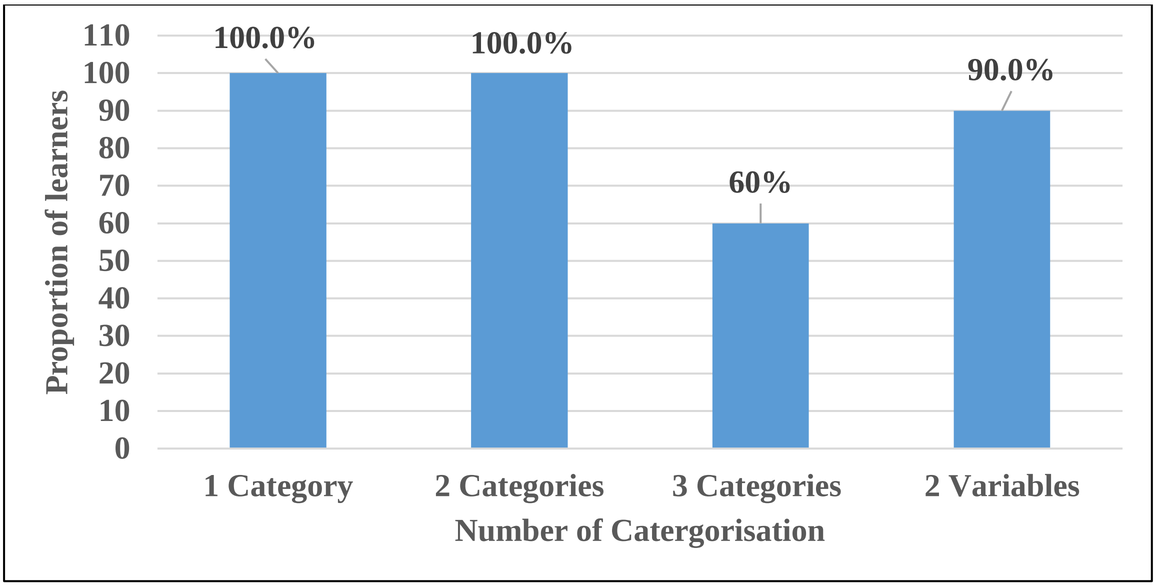


Figure 6: Intervention Group Post-test Results

The post-test results of the intervention group revealed a marked improvement in performance among the learners in sorting and classifying objects. It is evident that nine out of ten members of the intervention group, translating to 90.0%, were able to sort transport vehicles using two variables at the same time. This suggests that a significant majority of the study participants from the intervention group were able to sort the transport vehicles accurately in different ways and in two ways at the same time. Further, all the study participants in the intervention group who used two variables at the same time to classify the transport vehicles used colour and kind as their way of classification. Further, the results of the study indicate that 60.0% of the intervention group was able to sort out the transport vehicles using up to three categories. This group classifies transportation vehicles based on their mode of locomotion, such as water, rail, or road, as well as their wheel types and numbers and vehicle size.

It also emerged that all of the intervention group were able to classify the transport vehicles in both the first and second categories. This was reflected by 100.0% of the participants who classified them in the first category and another 100.0% who classified the transport vehicles in a second category. During sorting, colour and kind of the transport vehicles were the most prevalent ways of categorising used by the participants. In the first category alone, 50.0% of the intervention group participants used colour and another 50.0% of them used kind as a way of sorting out the transport vehicles.

In addition, during the second categorisation at the post-test stage, the use of colour and kind were still the most predominant method used by the learners. Those who used colour in category one, used kind in category two, and vice versa. Another way of classifying the transport vehicles, as used by the intervention group in the second categorisation, was the texture of the vehicle.

On the learners' classification ability ratings, the results show that, on average, the overall mean rating on the ability to classify objects was 4 on the scale of 1 to 5 among the study participants in the intervention group during the post-test. This indicates that their ability to sort the transport vehicles accurately in different ways and in two ways at the same time at the post-test stage was generally high. At least half (50.0%) of the study participants in the intervention group had a rating of 5 out of 5, 40% had a rating of 4 out of 5, and only 10% were rated at 1 out of 5 in classification skills.

4.6.1b. Post-test Results among the Control Group

Figure 7 shows the summary of post-test results for the control group.

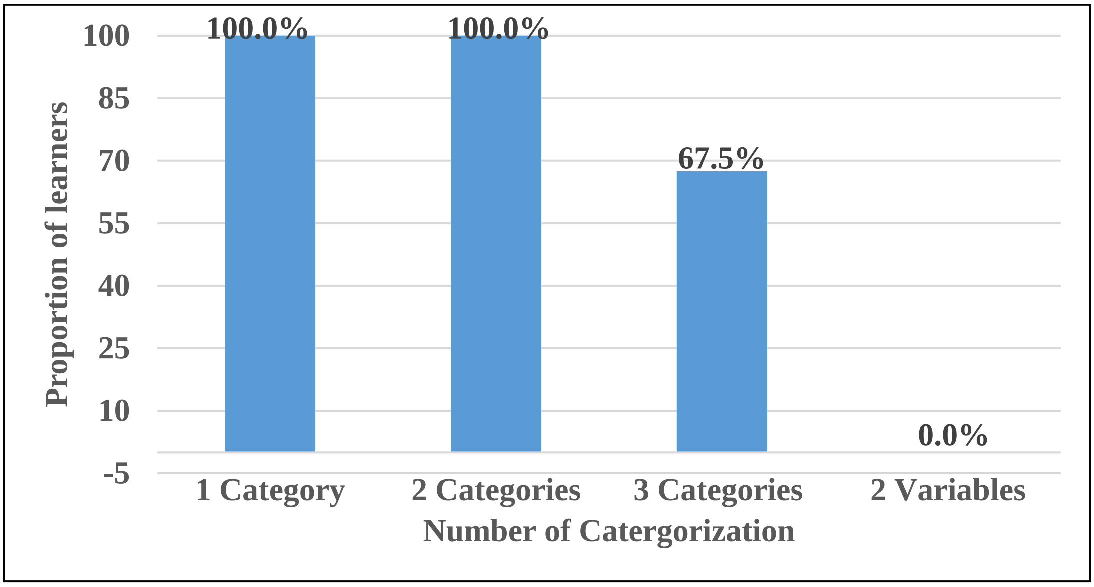


Figure 7: Control Group Post-test Results

Figure 7, which shows the post-test results of the control group, reveals that none of the study participants was able to sort out the transport vehicles in two variables. This suggests that, despite the passage of time, none of the participants in the control group were able to sort the transport vehicles accurately in two ways simultaneously.

However, as in the pre-test stage, it emerged that the majority of the control group participants were able to classify the transport vehicles in a third category. This was revealed by 67.5% of the participants who could classify the transport vehicles according to a third category, and all the participants were able to categorise the transport vehicles in two different ways. During sorting, colour and kind of the transport vehicles were still the most common ways of classification used by the learners in the control group. Other ways of sorting the transport vehicles used by the control group include their mode of transport, such as water, rail, and road, type and number of wheels, speed, crash or not and number of people the vehicle can transport.

In general, the results show that, on average, the overall ability rating to classify transport vehicles among the study participants in the control group was 2.6 in the scale on 1 to 5. This implies that their ability to sort the vehicles accurately in different ways and in two ways at the post-test stage was average. The results reveal that 62.5% of the study participants in the control group had a rating of 3 out of 5, and 37.5% were rated at 2 out of 5 in classification skills during the post-test stage.

4.6.2. Comparing post Classification Ability by Age of the Grade R Learners

The study sought to investigate the effect of age on learners' abilities to sort and classify objects, after a period of four weeks. The Mann-Whitney U-test, which is a non-parametric alternative to an independent samples t-test, was used to investigate the differences. The Mann-Whitney U-test results are shown in Table 4.

Table 4: Hypothesis Test Summary

	Null Hypothesis	Test	Mann–Whitney *U*	Sig	Decision
2	The medians of Posttest Intervention Group are the same across categories of Age of Learner.	Independent-Samples Median Test	2.50	.114	Retain the null hypothesis.
4	The medians of Posttest Control Group are the same across categories of Age.	Independent-Samples Median Test	.686	.102	Retain the null hypothesis.

The Mann Whitney test results in Table 4 indicate that the median scores of the learners' ability to sort and classify objects in the intervention group were not significantly different given different ages of the learners. This was revealed by the fact that the distributions in the two groups did not differ significantly, as signified by Mann–Whitney *U* = 2.50 translating to a *P value=.114* > 0.05 (two-tailed). This finding implies that age has no effect on Grade R learners' ability to sort and classify objects among the intervention group.

Likewise, the results of the study established that the median scores of the learners' ability to sort and classify objects in the control group were equally not significantly different between the ages of the learners. This was revealed by the non-significant different distributions of the classification scores in the two groups. This was inferred by a Mann–Whitney *U* = .686, *P* =.114 > 0.05 (two-tailed). The findings therefore have shown that the age of Grade R learners have no significant impact on their ability to sort and classify objects, even after all the learners are taken through the *Let's Think!* lesson.

4.6.3. Qualitative Data Analysis

The main themes that emerged were facilitator intervention, group work, and learning from others.

Theme 1: *Facilitator intervention*

Although the data collection focused on the children and their responses, it is clear that the facilitator played a significant role in terms of providing a 'safe space' through relationships, offering clarity, assisting with vocabulary, and possessing a firm foundation in early childhood mathematics. These form the subthemes under facilitator intervention.

Sub-theme 1: Relationships

Perry and Dockett (2002) state that the key to successful learning is relationships. Children need to trust their teachers and are more likely to display different competencies in a 'safe space' rather than in an unfamiliar environment. When the facilitator arrived at school, the boys rushed excitedly to greet her. One boy even asked her to sort out a dispute in the sand pit, as if she were still a teacher there. As the facilitator worked with the boys whose parents granted permission, others were disappointed and asked when it was their turn during all three days of her presence at school. Several of the boys shared personal information during the observation sessions, as below:

C1: "I can spell cat. It's so easy."

C4: "You know my daddy also works at WITS."

C8: When asked if the child gave permission, he stated, "Of course I want to help you!"

C10: "My birthday was before last week Thursday. My sister's going on camp for just one night with only her teacher."

C14: "Tomorrow I'm turning six."

C15: "I watched 'My Octopus Teacher' yesterday and the octopus taught the man. I was very surprised."

C9 also leaned against his teacher during the intervention lesson, showing his ease and comfort.

It is evident from these excerpts that the boys and the facilitator shared warm relationships, and the facilitator was trusted by the boys. Only one boy out of 19 did not grant his permission to be part of the research. Even with the knowledge that any of the boys could stop participating at any stage during the data collection, this did not prevent them from completing the activities. The relationship built between the facilitator and the boys earlier on in the year was significant in getting them to participate and to accept challenges.

Sub-theme 2: Language

Ellerton, Clarkson and Clements (2000) discuss the role of language in developing mathematical ideas, as this is a necessity for children to be able to interact with each other and the teacher by communicating their ideas. Throughout the observation process and during the intervention lessons, the facilitator constantly corrected information and emphasised mathematical language.

"Sorting means putting things that are the same or similar together."

"Okay, so now you have sorted according to colour."

"Are these all *the rabbits, or just* some *of the rabbits?"*

"Could you sort these in a different way now?"

"Making patterns is not sorting."

"Now you have sorted according to the kind of animal they are."

Aside from the mathematical language, the teacher also corrected general vocabulary and the plurals of animals. In one case, C1 used the word ‘rhyming’ to communicate that he could see the groups of animals were the same. The language mediation from the facilitator was particularly important for four out of the ten boys in the intervention group who were second-language speakers.

Clearly, the facilitator consistently corrected and promoted the correct language during the course of the data collection. This is beneficial and imperative in order for the boys to grasp the mathematical concepts effectively.

Sub-theme 3: Responses

According to Adhami et al. (1998), using a cognitive dissonance approach “places two major demands on the experience and expertise of teachers”. They suggest that the facilitator should know each child’s strengths and weaknesses and be aware of their cognitive abilities. They also stress the importance of teacher intervention and mediation in promoting peer interaction in order to implement a cognitive dissonance lesson effectively. A strong component of the intervention lessons involved asking questions, problem solving, and encouraging suitable responses. It was imperative for the facilitator to ask questions or encourage certain behaviours throughout the lesson to guide the learning process. Some of these included the following:

“Ooh, I like the way you added a bit more information by saying the dog was red.”

“What do you notice now, boys?”

“What do you mean? Can you explain that further?”

“Show us what you mean by that.”

“Do you like his idea?”

“Can you tell us why you put that card there?”

“Could you explain why you moved his card?”

“Share your idea with us.”

“Tell us what you are thinking.”

Without these sorts of interventions, the lesson would not be guided, group work would not be promoted, and the cognitive dissonance approach would not work. The facilitator’s role, as indicated above, assisted the boys in working effectively together and encouraged them to verbalise their thinking and metacognition.

As indicated through the sub-themes, the facilitation of the cognitive dissonance approach is paramount in its implementation. To ensure that the intervention lessons were successful, the facilitator needed to understand the mathematical concepts being developed through the lessons and have a sound knowledge of the learning of mathematics in early childhood. The questions she asked indicated scaffolding and making use of the zone of proximal development. Although both groups achieved the challenge, the *Let's Think!* programme does not always need to lead to tangible learning outcomes, as the emphasis is on subtle learning. It is clear though, that the noteworthy role the facilitator played in building relationships, possessing intricate knowledge on early childhood mathematics, and promoting problem-solving through active learning resulted in a successful experience for the intervention group.

Figure 8: Intervention group 1 result

Figure 9: Intervention group 2 result

***Theme 2**: Group work*

The use of group work has been well documented over the years. The research of Sofroniou and Poutos (2016, p.1) on group work in mathematics highlighted the benefits thereof: “Group work permits students to develop a range of critical thinking, analytical and communication skills; effective teamwork; appreciation and respect for other views, techniques and problem-solving methods, all of which promote active learning and enhance student learning.” Due to the Vygotskian nature of the *Let’s Think!”* lessons, effective group work was mandatory. However, at such a young age, the skills necessary for successful group work need to be explicitly taught. The facilitator was instrumental in reminding the boys of how to work co-operatively at the beginning of the interventions.

“Do you remember when we worked in these groups before? What is important to remember?”

“Remember that we need to listen to each other’s ideas.”

In response to a child focusing on the cards, the facilitator responded*, “It’s less about the cards and more about how you manage yourselves. Remember that when we work in a group, you don’t take stuff for yourself. Remember when we put the sticks in order in our group? Remember that we couldn’t keep them for ourselves; you needed to work together as a team. So, you need to remember that you are listening to each other and sharing ideas.”*

The boys in both intervention groups initially had forgotten how to work together and needed reminding of the sort of language to use and acceptable social behaviour.

“No, you’re not whispering because you’re working together in a group. Use your big voice, and say something like, ‘I think we should sort by…"

*“Don’t say ‘*We are sorting this way’*. Rather say, ‘*Guys, why don’t we…’ *or ‘*Should we sort by colour?’ *and see if everyone agrees.”*

In both groups, they also needed reminding about assisting each other, and there was a strong tendency for the boys primarily to work individually at first. In the two lessons overall, the facilitator had to comment 15 times about working in groups instead of working alone. Some of her comments to assist with this are indicated here:

“If you see someone else’s card they’re working with, what can you do?”

“Oh look, he found a card you’re collecting. Say ‘thank you’.”

“Remember that we’re working in a team so put all your things in the middle.”

“Good, C3, I like the way you’re helping C1 with his pile. Well done.”
“Remember to share your ideas before going ahead.”

In order to implement successful group work and to ensure that the boys were learning more about classification from each other and not from the facilitator, as per Vygotsky’s theory of learning, explicit teachings of how to do this were necessary. The observations above clearly indicate the difficulty the boys had working in a group instead of individually and independently and how the facilitator was responsible for remedying this in order for the lessons to be effective.

Theme 3: *Learning from others*
An essential element of using the cognitive dissonance approach and making use of Vygotsky’s theory of the zone of proximal development of learning from others as opposed to ‘talk-and-chalk’ teaching methods. To this end, there are many factors to take into consideration when working in groups with young children. Adey et al. (2001) suggest working with children in groups of six, with mixed abilities. However, there were only ten children who were involved in the intervention lessons, so they were put into two groups of five children each. For these groups, the facilitator was deliberate about choosing participants in each group so that each one had at least one strong academic child from whom the others could learn. This is clearly based on Vygotsky’s zone of proximal development, where the ‘knowledgeable other’ could be peers, and not necessarily the teacher.

Group 1 consisted of C1, C3, C4, C8, and C10. In this group, C3 and C10 were identified as strong academic children. During the lesson, these two made connections while C4 was an onlooker. The youngest child, C8 was surprisingly quick to pick up the pattern of the challenge, even correcting others. By the end of the lesson, it was evident that all five boys understood where the various cards belonged and why. This lesson took only fifteen minutes for the boys to complete, although they had half an hour to do it in.

Group 2 consisted of C5, C6, C7, C9, and C11. In this group, the facilitator identified C6 and C7 as the strongest academics. However, C9 was the most vocal and initiated most suggestions, followed by C7. C5 simply repeated what the other boys said, and it took him a while to understand the concept. C6 did not contribute vocally to the lesson as predicted, but he did quietly correct other children's mistakes by moving the cards. C5 and C6 were the only two boys who did not classify the transport objects in the post-test with two variables at the same time. C11 did not understand until right at the end, and made the incorrect observations *"If they're slow, that means they're fluffy."* This group took twenty minutes to complete the lesson.

The facilitator observed carefully throughout the lessons to see which boys had grasped the concept and which had not. As a result of the boys being placed deliberately in their groups, they were able to reach the correct conclusion in both groups without the facilitator needing to 'teach' anything. This is a clear illustration of learning from each other. Working in groups is an effective method, reinforced by Sills, Rowse and Emerson (2016), who observed that collaboration is especially advantageous for children with lower abilities when there is a discrepancy in abilities.

Another observation that arose was that when the boys who participated in the intervention lessons worked alone during the pre-tests, their classification options were limited. However, during the group work, there were a number of astounding observations, and by giving each boy an opportunity to place a card at the end of the lesson, it was easy to ascertain that all ten boys had understood the lesson. There was much joy and delight shown when they realised, they had been able to complete the challenge.

C8: "Now I understand!"

C9: "We've done the impossible!"

C5: "YES!" (throwing his arms in the air)

Bearing in mind that the focus of the lessons is not to reach a conclusion but to induce deep thinking and problem solving, it is nonetheless enthusing and motivating for both the children and the facilitator if this happens. Experiencing success, as indicated by the observations, would mean that their achievement would lead to wellbeing (Clarke, 2020).

To support the theme of learning from others, clear reference was made by the boys during the post-test of the intervention group. As seen below, several children made reference to the *Let's Think!* lesson when asked how they knew what to do.

C3: "Like when we did it yesterday. It makes me feel like I wanna do it."

C4: "I'm doing the same things as with the animals"

C8: "I remember because of when we played a different game with the animals. It's actually pretty good."

C10: "I just remember how to do it from the classroom."

C11: "That's how we did it with C7 and C5 and all the guys who helped me."

From the qualitative results above, it could be argued that the boys learned new skills during the lessons without any direct content being taught by the teacher. This confirms that the group work was effective in helping the boys learn from each other.

4.7. Effect of Cognitive Dissonance Approach on Classification Ability among Grade R learners

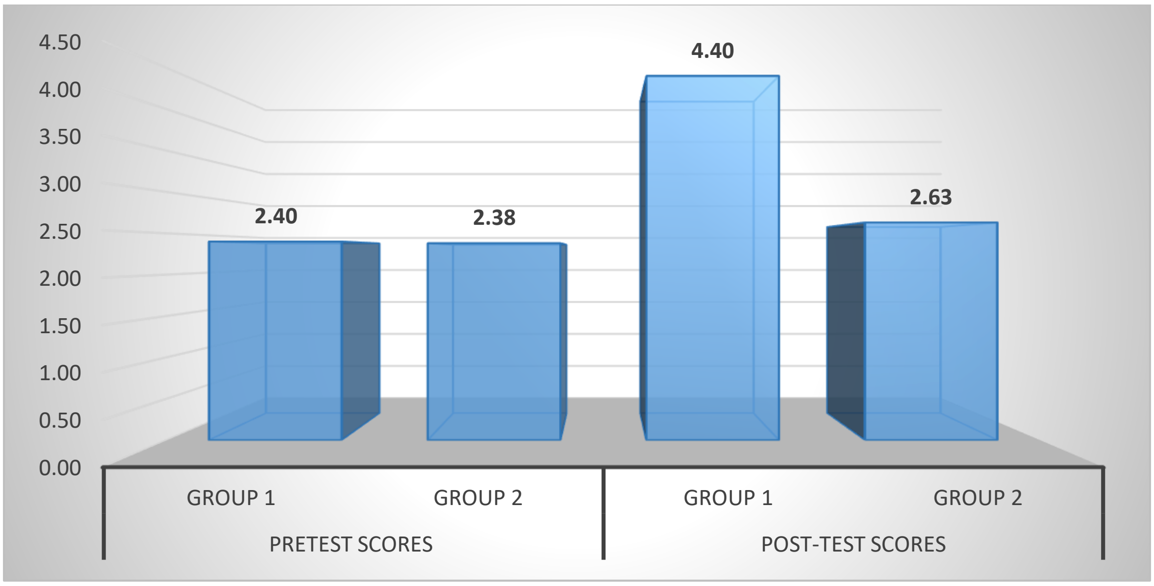
The last objective of the study sought to investigate the effectiveness of using a cognitive dissonance approach in enhancing classification ability among Grade R learners. The objective was addressed by testing the null hypothesis, "*Cognitive dissonance approach has no significant effective on enhancing classification ability among Grade R learners*." The hypothesis was tested using experimental data, where two groups of Grade R learners were considered: intervention group and the control group. Group 1, the intervention group, was treated by training them on classification skills using a cognitive dissonance approach through exposing the learners to *Let's Think*! lessons. On the other hand, Group 2, the control group was not treated, but only received traditional teaching. A pre-test for sorting assessment was administered to both the intervention and control groups. After the pre-test, learners from the intervention group received intervention using a *Let's Think!* lesson, while those from the control group continued receiving their usual lessons without any intervention. After the intervention period expired, a post-test was administered to both groups. Given that the study used the standard pre-test-post-test two-group design for both the intervention and control groups, both independent and paired sample tests were used to determine the difference in classification ability between the two groups. The different combinations of pre-tested and post-tested treatment and control groups allowed the researcher to ensure that confounding variables and extraneous factors did not influence the results. Classification skills were measured by gauging the learners' ability to sort and classify objects. Table 5 shows the groups and descriptive statistics of their performance in classification skills.

Table 5: Descriptive Statistics of the Scores of the Two Groups - Classification Skills

Group		N	Median	Mean	Std. Deviation	Std. Error
Pretest scores	Intervention Group Pretest (Grp 1)	10	2.50	2.40	0.40	1.27
	Control Group Pretest (Grp 2)	8	2.00	2.38	0.18	0.52
	Overall mean	18		2.39	0.29	0.89
Post-test scores	Intervention Group Posttest (Grp 1)	10	4.50	4.40	0.22	0.69
	Control Group Posttest (Grp 2)	8	3.00	2.63	0.18	0.52
	Overall mean	18		3.52	0.20	0.61

Source: Classification Skills Scores (2022)

Table 5 shows the descriptive statistics of the pre-test and post-test scores of both the intervention (Group 1) and control groups' (Group 2) classification skills. It is evident that the highest scores in classification skills were the post-test scores from Group 1 (intervention group). The median and means scores recorded for the post-test of Group 1 learners' ability to sort and classify objects were 4.50 and 4.40 (SD=0.22), respectively. However, the lowest score recorded was from pre-test classification skills test results for Group 2 learners (Median=2.00, Mean=2.38; SD=0.18). It is clear that pre-test scores were all lower than post-test scores in the learners' ability to sort and classify objects. This was further demonstrated by a bar chart in Figure 10.



Key: Group 1 - Intervention group; Group 2 - Control group

Figure 10: Learners' classification skills between intervention and control scores within pre-test and post-test scores

The results indicate that the intervention group showed relatively higher learners' abilities to sort and classify objects than their counterparts who did not receive treatment. Equally, post-test scores were higher than the pre-test scores in both the study and intervention groups compared with the control. However, to investigate whether there is any statistically significant difference in learners' ability to sort and classify objects between intervention and control groups, four different pairs of groups were compared. A comparison of the mean of the distribution of the four different pairs was desired, but due to the non-normality of the variables, a Wilcoxon signed-rank test analysis, which is a nonparametric method, was carried out and the findings are shown in Table 6.

Table 6: Pairwise Comparison of Pre-test and Post-test Scores for Control and Intervention Groups in Classification

Pair	Groups	Mean	Median	Mean Rank	Sum of Ranks	Z	Asymp. Sig. (2-tailed)
Pair 1	Group 1 pretest - Group 2 pretest	2.40 2.38	2.50 2.00	3.33 3.67	10.0 11.0	-0.108	.914

Pair 2	Group 1 pretest - Group 1 post-test	2.40 4.40	2.50 4.50	0.00 5.00	0.00 45.00	-2.701	.007
Pair 3	Group 2 pretest - Group 2 post-test	2.38 2.63	2.00 3.00	0.00 1.50	0.00 3.00	-1.414	.157
Pair 4	Group 1 post-test – Group 2 post-test	4.40 2.63	4.50 3.00	4.00 0.00	28.00 0.00	-2.456	.014

Key: Group 1 - Intervention group; Group 2 - Control group

Source: SPSS Output

From Table 6, pair 1 is a comparison between the intervention group and control group's pre-test scores on classification skills. The pre-test scores in the two groups were compared to establish whether the randomisation process was effective, which provided an opportunity for confirmation that the experimental noise and confounding variables were filtered out. Further, it ensured that internal validity was met because the pre-test results gave an understanding of the equivalency of the two groups.

A preliminary test on the data indicates that the variances of the two groups are not equal, suggesting abnormally distributed data. Hence, using a Wilcoxon signed-rank test analysis, it was established that there was no statistically significant difference in classification skills pre-test scores between the control and experimental groups $Z = -0.108$, $p = 0.914$. Indeed, the median classification score ratings for the intervention group pretest (M=2.00) and control group pretest (M=2.50) did not differ significantly. This finding indicates that the two groups did not have notable differences in scores before the intervention, thus indicating that the randomisation process was effective. It confirms that the intervention noise and confounding variables were excluded, suggesting adequate internal validity.

Further, a Wilcoxon signed-rank test was used to investigate the existence of differences between pre-test scores and post-test scores for the intervention group, as shown in pair 2. The differences in the pre- and post-test scores would indicate whether the *Let's Think!* lesson intervention is effective or not. From the findings, the mean of the negative ranks was established to be larger than that for positive ranks, suggesting that values for the post-test are generally larger than for the pre-test results. The Wilcoxon signed-rank test results in a Z statistic of -2.701 which results in an exact *p*-value of .007, which is statistically significant. Therefore, there is enough evidence to reject the null hypothesis of equal medians for the two scores. This suggests that the *Let's Think!* lesson elicited a statistically significant change in the learners' ability to sort and classify objects. Clearly, the median classification score rating for the post-test (M=4.50) was evidently higher than the pre-treatment score (M= 2.50). Thus, given that the difference between pre-test and post-test scores for the intervention group was statistically significant at the 1% level, the null hypothesis was rejected, and it was concluded that the cognitive dissonance approach has significant effect on enhancing the classification ability among Grade R learners.

On the other hand, it is not known whether the existing difference in learners' ability to sort and classify objects was exclusively due to the use of the cognitive dissonance approach or any other superseding variable that was not included in the study. For that reason, the study further explored the solution with a two-control group design as a refinement of the finding. This was investigated using the Wilcoxon signed-rank test on pair 3 (Control Group Pretest – Group 2 and Control Group Post-test - Group 2). The results revealed that although there was a positive paired sample correlation, there was no statistically significant difference between pre-test scores and post-test scores in the classification ability within the control group [$Z = -1.414, p = .152$ *(ns)*]. Nevertheless, looking at the descriptive statistics of the control group, there is evidence that learners' ability to sort and classify objects score at pre-test improved from a mean of 2.38 (*Median* = 2.00) to a mean of 2.63 (*Median* = 3.00) at post-test score translating to a rise of 0.25. This finding indicates that even though there was improvement in learners' ability to sort and classify objects, the improvement was not statistically significant. Nonetheless, at least some improvement in learners' ability to sort and classify objects was expected, because the learners, though being in the control group, were being taught using the traditional method of teaching classification skills.

Further investigation is needed to establish whether the significant difference found between the pre-test and post-test scores for the intervention group was solely attributed to the treatment factor or other factors. This was done by conducting a test on pair 4 that checked whether there was any significant difference between the post-test scores of the intervention and control group learners. Wilcoxon Signed rank test analysis result shows that there was a statistically significant difference between the intervention group post-test (Group 1) and control group post-test (Group 2), $Z = -2.456, p=.014$. The median scores in post-test exams for the intervention group

(*Median* = 4.50) were significantly higher than the post-test median score for the control group (*Median* = 3.00). This rise in median score excludes the influence of pre-test procedure on the score; hence, it can be concluded that the statistically significant difference in mean scores noted was mainly attributed to the treatment effect, which means that the *Let's Think!* lesson has a significant impact on learners' abilities to sort and classify objects.

Specific attention was paid to the five boys identified in the intervention group as requiring extra support in the classroom. The results shown in Figure 11 indicate the improvement in Children 3, 4, 8, 9, and 11 from the pre-test to the post-test. This is particularly exciting, as it indicates that the *Let's Think!* intervention was an effective tool for learning amongst these specific boys.

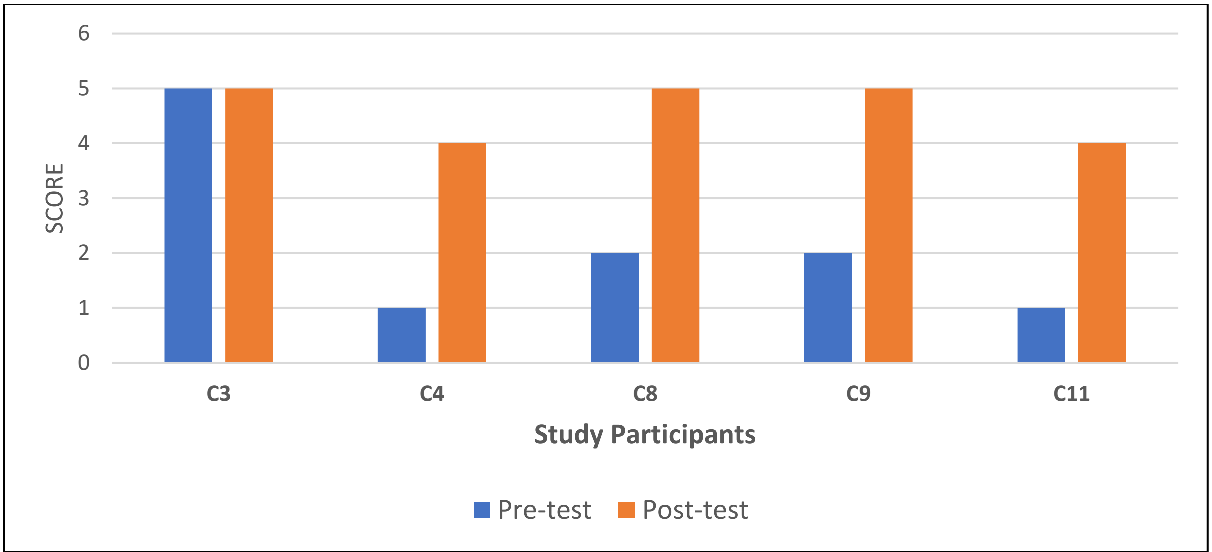


Figure 11: Pre- and post-test comparison in boys requiring extra support

4.7.1. Qualitative data analysis

From the analysis of qualitative data obtained from interviews and observation, one main theme that emerged was the improvement among Grade R learners.

Theme 1*: Improvement among Grade R learners*

The findings of the study reported that the cognitive dissonance approach was highly effective in improving several aspects among Grade R learners. From the analysis of the data on the effectiveness of the cognitive dissonance approach among Grade R learners, the sub-themes that emerged included improved sharing of ideas, group work involvement, attitude, and inclusion success.

Sub-theme 1: Improved sharing of ideas

The findings of the study indicated that the cognitive dissonance intervention enhanced the way in which the learners shared their ideas during group work. This further facilitated the effectiveness of working together, which led to a better understanding of the classification of objects. The following dialogue excerpts are in support of the above-mentioned sub-theme:

C3: "I think we should sort by sorting the dogs out."

C9: "Why don't we sort by colour?"

C10: "I agree with everything."

C5: "Who needs green?"

C9: "I think I have an idea. Is the group okay if we make the rows down of the same animals, but if for instance we have a duck, we put it over there."

C5: "I suggest that we do this."

C9: "I do not think this is a good idea."

C7: "Everyone's agreeing with me because I sorted this out."

From the qualitative results above, it is clear that the boys began to share their ideas and opinions in a more coherent way, thinking about their interactions before spontaneously taking action on their own. Therefore, it could be concluded that the cognitive intervention enhanced the boys' ability to share their ideas, which further facilitated knowledge on the classification of objects.

Sub-theme 2: Improved involvement in group activities

The findings of the study also indicated that the Grade R learners reported improved involvement in group tasks that were presented by the teacher during the intervention. The intervention provided an opportunity for the Grade R learners to engage in collective tasks in classifying objects, which further enhanced their understanding of the tasks required. Thus, the way in which the boys went from working in isolation to discovering the benefit of working cooperatively, is apparent in the following responses after the facilitator asked what had worked well during the session:

C3: "Um, we're all working as a team."

C10: "It means that you make good progress."

C1: "Because there's only one brain there, and one, two, three, four five, six … and six brains here."

C3: "Whenever I try to like sort it, um, like I don't have, there's no many brains and then I can't do it just alone."

C9: "Maybe some of our action gave us, um, ideas."

The qualitative results above illustrate that the boys realised the benefit of group work. When asked if they would choose to do a similar activity individually or in a group, they all agreed they would prefer to work in a group. Therefore, it can be concluded that the adoption of the *Let's Think!* intervention fostered interest in group tasks and the benefits of working together, and this enhanced understanding of classification of objects by the Grade R learners.

Sub-theme 3: Improved attitude

The third area of improvement was the positive changes in attitude in both groups over the period of data collection. The findings of the study also indicated that the *Let's Think!* intervention was effective in enhancing the learners' attitude towards performing the classification tasks that they were assigned. Therefore, the results further revealed that there was no confusion among Grade R learners in the post-tests for either group as to what the term 'sorting' meant, so an improvement of the concept is undeniable. Moreover, all boys in both groups improved their speed during sorting.

In the control group during the post-test, although there was not a significant improvement in their ability to sort, they did refer to the experience as a positive one.

In relation to this sub-theme, some Grade R learners who participated in the intervention group reported that:

C12: "I did think a lot. I did like it a lot."

C13: "Now I know that you can do anything, like the dinosaurs."

C15: "I liked it."

C16: "Please time me. Please fast, because I love fast."

From the qualitative results above, it is evident that the adoption of the *Let's Think!* intervention developed a positive attitude towards the tasks involving the classification of objects. As reported from the results, in the post intervention group tests, the boys experienced feelings of success. Therefore, it can be concluded that the intervention reinforced learners' interests in performing the classification of objects through the development of a more positive attitude.

Sub-theme 4: Improved ability of children in need of assistance
The findings of the study from observations also indicated that learners who struggled in various areas improved in their general behaviour after the intervention. Thus, some learners who had challenges before being involved in the intervention later reported positive transformations in their behaviours in the classroom. Below are observations on what happened during and after the intervention lesson with these children.

C3 has behavioural issues and is often in fights with other children in the grade. However, during the lesson, he was engaged throughout and showed no display of aggression at any time.

C4 attends both speech therapy, because he is not completely verbal, and occupational therapy. Throughout the lesson, he only spoke once spontaneously to say that he was collecting 'sheeps'. When asked if the activity was challenging, he responded by saying, "*Grateful*," making it difficult to ascertain his level of understanding. During the pre-test, C4 was only able to sort according to colour and then started making patterns. During the post-test, he was able to sort in two different ways and according to two variables simultaneously.

C8 is the youngest boy in the intervention group, and although he was an active participant in the lesson, there was doubt as to whether he had understood the concept. During the post-test, he was able to classify in three different ways, as well as according to two variables simultaneously.

C9 has been diagnosed with ADHD but has not yet received any medication or other intervention for this. The following excerpts illustrate his level of distraction during the lesson:
"I need ducks! I need ducks! I need ducks!" (yelling)

"Hey guys, I need ducks and…I need ducks and I need ducks and bunnies. I need ducks and bunnies, man. I need ducks and bunnies. I need…I got me a bunny! I need ducks!"

"I got this dog. Dog. Dog. Dog. Bunny. Dog. Bunny."

He then collected all his cards in a pile but did not sort them, and the facilitator needed to intervene.

"I need dogs. Dogs. Gimme dogs."

"Duck, duck, goose" (randomly referring to a playground game)

"There's some poking grass here." (distracted by his shoes)

At this stage, he needed reminding to be part of the lesson, and then he said, "*This is impossible."*

"Okay, so, so, so, so, so if this is the…but if for instance, let's say, let's say this is a duck, but, but, but, also, let's say, for instance, let's say, okay." He had difficulty explaining what he wanted to say, and then lost focus again.

"Some of us already have our shoes."

However, when following the metacognition stage of the lesson, C9 was able to explain to another child, *"…so the red dog goes over there, but the yellow one goes over there."* Despite his high level of distraction, he was able to sort according to three different variables independently, as well as two simultaneously.

C11 attends occupational therapy lessons, as well as speech therapy and struggles with day-to-day functioning in the classroom. During the intervention lesson, he was visibly excited about sorting the cats and shouted with delight each time he found one. However, when asked to contribute to the activity sorting according to two variables, he placed his card in the incorrect place. When the others corrected him, he responded by saying, "*I got suddenly confuse-ed".* Surprisingly, during the post-test he managed to sort according to two variables simultaneously without assistance, and when asked how he knew what to do, he said, "*Because I'm very smart".*

According to the findings, the cognitive dissonance approach benefited all of the boys in the intervention groups, but especially those who would normally require extra support and assistance in the classroom. This indicates that this particular method is effective for inclusive education.

The subthemes above demonstrate general improvement in several areas following the intervention, indicating that the cognitive dissonance approach was effective in teaching this concept. In the control group of eight boys, only three of them improved slightly. However, in the intervention group of ten children who were exposed to classification using cognitive dissonance, nine children showed improvement in the number of variables they were able to apply, with the tenth boy who had already been able to classify two different ways simultaneously in the pre -test. This irrefutably proves that the cognitive dissonance approach, as used in the *Let's Think!* lessons, is notably effective in enhancing the classification ability among Grade R learners.

4.8. Conclusion of chapter

This chapter presented the findings and interpretation of the study as indicated in the research methodology, using qualitative and quantitative data. The next chapter presents the study's conclusion and recommendations.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

This chapter provides a brief summary of the results and a discussion of the findings, as well as the conclusions and recommendations arising from the research methodology that guided the study. This study investigated the effectiveness of a *Let's Think!* lesson on the classification of objects among Grade R boys in one mainstream preschool in Gauteng, South Africa. The summary of results is first presented.

5.2. Summary of findings

5.2.1. Ability to classify before the implementation of the *Let's Think!* lesson

The first objective of the study was to use a cognitive dissonance approach to assess how Grade R students classify a group of objects prior to the implementation of the *Let's Think*! lesson. The quantitative pre-test results indicated that in the control group, 100% could sort according to one category, 87.5% could sort a second way, only 37.5% could sort according to a third category, and none of the boys could sort using two variables at the same time. In the intervention group, all the boys could sort according to at least one category, 70% could sort a second way, 50% could sort a third way, and only one boy out of ten was able to sort the dinosaurs according to two variables at the same time. The quantitative data thus indicates that with a mean of 2.4 for the intervention group on a scale from 1 to 5, and a mean of 2.38 for the control group, both groups could be considered to have a generally low ability to classify a group of objects in various ways. Only 5.5% of all the participants could sort using two variables at the same time.

The qualitative results reported that some of the difficulties they encountered were not understanding the mathematical language used for the instructions and then experiencing negativity and giving up when they perceived the task to be too difficult.

5.2.2. Ability to classify a group of objects after the implementation of the *Let's Think*! lesson

The second objective of the study sought to assess how the Grade R learners classify a group of objects after the implementation of the *Let's Think!* lesson using a cognitive dissonance approach. The quantitative results indicated that the control group, which had received no intervention, showed a slight improvement in that all group members were able to sort transport vehicles two different ways and two additional children could sort a third way. However, none of the boys in the control group were able to classify the vehicles in two different ways at the same time. In comparison to this, the intervention group's post-tests revealed a marked improvement in performance among the learners in sorting and classifying objects. Nine out of ten members of the intervention group, translating to 90.0%, were able to sort transport vehicles using two variables at the same time. The qualitative results indicated that after the implementation of the *Let's Think!* lesson, there was enhanced teacher facilitation, group work, and boys learning from others, indicating that the intervention was effective in impacting knowledge of classification among learners.

5.2.3. The effectiveness of a cognitive dissonance approach in enhancing classification ability in Grade R

The study finally sought to investigate the effectiveness of using a cognitive dissonance approach in enhancing classification ability among Grade R learners. The results from the descriptive data of pre-test and post-test scores of both the intervention and control groups' classification skills illustrated that the highest scores in classification skills were the post-test scores from the intervention group. In addition to this, the Wilcoxon Signed rank test was used, and resulted in a Z statistic of -2.701, equal to an exact p-value of .007, which is statistically significant. Therefore, there is enough evidence to suggest that the *Let's Think!* lesson elicited a statistically significant change in the learners' ability to sort and classify objects.

Moreover, the qualitative results indicated that there was also an improvement in the boys' sharing of ideas, group work cooperation, and attitude. Lastly, five out of the ten boys in the intervention group were considered to need extra support, and all five of these boys were able to classify according to two variables at the same time, implying that the *Let's Think!* programme is a viable option for inclusive education.

5.3. Discussion on Findings

The following section includes a discussion of the findings of the data, as well as the themes and related literature reviews.

5.3.1 The ability to classify before the *Let's Think!* lesson

The study examined how boys classified a group of objects before a cognitive dissonance intervention. The quantitative findings of the study indicated that in both the control and intervention groups, the boys' ability to classify some dinosaur toys in several ways, using two variables at the same time, was generally low. The reasons for this are indicated by the findings of the qualitative data, which showed that thirteen out of the eighteen boys had difficulty sorting because they initially did not understand the instruction. This is contrary to the standards implemented by the Department of Basic Education, which states that children moving *towards* Grade R should continue to sort, classify, and make comparisons, as well as use the related language (2015:55). It is, however, in line with Hornburg et al.'s (2018) research on the connection between mathematics language and understanding certain numeracy skills. This is also confirmed by Bezuidenhout's (2022) findings that our South African children perform repeatedly poorly on mathematics assessments, both locally and internationally, because of a lack of exposure to quality mathematics-specific vocabulary, which is a key tool for early number concept development. Using the correct mathematical language is imperative (Rudd et al.,2008; Ledibane et al., 2018), and there are a number of studies questioning our language policy in South Africa with regards to mathematical learning (Robertson et al., 2020; Essien & Sapire, 2022; Feza et al., 2022), as using English as the predominant medium has major implications for second-language learners who could already be marginalised due to socioeconomic circumstances. The results of the initial part of this study are concerning, as one would imagine that not understanding mathematical language would not be prevalent in affluent areas with quality education.

The qualitative findings of the study also indicated that, due to difficulty in understanding instructions using mathematical language, some of the boys expressed negativity and no longer wished to participate in the pre-test task. Thus, during the pre-test, most of the boys gave up when the task became too difficult. Although this is not a surprising response because negative emotions are connected to avoidance motivation (Gray, 1987), it is a disappointing response because Chen et al. (2018) suggest that a positive attitude towards math is a predictor of future mathematical achievement and is related to an improvement of the hippocampal learning and memory system.

In summary, it was evident that Grade R learners viewed themselves as incapable of sorting the objects more than two ways before the intervention, and experienced challenges with comprehending how to carry out the tasks. This implies that the learners were struggling with the classification of objects in the classroom.

5.3.2. The ability to classify a group of objects after the implementation of the *Let's Think!* lesson

The study also explored how boys classified a group of objects after experiencing a cognitive dissonance intervention, using a *Let's Think!* lesson. The quantitative results showed that there was a substantial improvement in the intervention group's ability to classify a group of objects after the *Let's Think!* lesson. It is essential to note that the improvement in the boys' abilities was not only because of the lesson in isolation but also due to the role of the teacher. This was evident in the qualitative data, where the relationship between the teacher and boys was advantageous as they engaged freely in discussions with the teacher and peers. In this study, as documented by Narea et al. (2022), the teacher-child relationship was key in promoting cognitive development. Given that the boys had to grant themselves permission to participate in this study and did so, it demonstrates their eagerness to do so. The results highlight that the teacher's role in creating the opportunity for exposure to the language and related activities assisted the boys in developing their mathematical language. “Teacher quality is …a key determinant of student learning” (Bold et al., 2017, p.2), and therefore teachers must possess both a sound understanding of subject content as well as effective pedagogic knowledge (Mabena et al. (2021); Rudd et al. (2008), Baroody et al. (2019), Mampane et al. (2018) and Setoromo et al. (2018). In this study, the teacher had been trained by one of the original researchers, Michael Shayer, in implementing the *Let's*

Think! lesson, and her competence in both knowledge and pedagogy was instrumental in the success of the intervention.

Added to this was the teacher's knowledge of the underpinning theories of this study and how to implement them. With the teacher's guidance, the learners successfully collaborated to reach a solution, which is consistent with the findings of Kutnick et al. (2008), Sofroniou et al. (2016), Veldman et al. (2020), and Hong et al. (2017), which all reported that the learners are able to work effectively in groups with guidance from the teacher. Furthermore, the result of an enriched understanding of the task for the boys was due to employing a Vygotskian approach that focused on societal relationships, as backed up by Walshaw (2017). The teacher deliberately grouped the children in accordance with Vygotsky's ZPD so that less knowledgeable children were able to learn from more knowledgeable children in the intervention. Although Sills, Rowse and Emerson (2016) observed that collaboration is advantageous for children with lower abilities when there is a discrepancy in abilities, as seen in the current study, they also claim that the children with higher abilities either regressed or did not benefit. This is in contrast to the findings of this study, which found that ALL children in the intervention group improved, with the exception of one boy who had already received full marks in the pre-test.

5.3.3. Effectiveness of a cognitive dissonance approach in enhancing classification ability

The study also examined if a cognitive dissonance approach, in the form of a *Let's Think!* lesson, would be effective in enhancing the classification skills of boys in Grade R. The quantitative data showed unequivocally that the *Let's Think!* lesson elicited a statistically significant change in the intervention's group's ability to sort and classify objects. In addition, the qualitative data indicated several other areas of progress. It was observed that the cognitive dissonance intervention enhanced the way in which the learners shared their ideas during group work. These findings agree with Veldman et al., (2020), which indicated that co-operative learning led to improved group work.

Furthermore, there was also clear evidence that the boys in the intervention group learned from each other, consistent with the views of Niklas et al. (2018), who claim that children's cognitive development comes about from interactions with more knowledgeable others. As is evident from the qualitative data, many boys were delighted with their marked improvement in their ability to classify objects. As stated by Finau et al. (2018), a math cognitive acceleration programme has a positive effect on motivation and mathematical achievement. The improvement in the boys' ability to classify objects after part of a cognitive acceleration programme was expected, as proven by previous research carried out by Shayer (2003), Adhami (2002), Adey, Robertson and Venville (2002), Oliver, Venville and Adey (2012), Robertson (2014) and Shayer and Adhami (2010) on the effects of a cognitive acceleration programme, namely*, Let's Think!.*

5.4. Conclusion

The study concludes that the learners struggled with classification tasks before they were exposed to the cognitive dissonance approach. The *Let's Think!* lesson was part of a cognitive acceleration programme that was implemented using a cognitive dissonance approach. The study further determines that the lesson had a significant impact on the intervention group's ability to classify. The study also concludes that there was an improvement in a number of different elements. These included the boys' ability to understand and use mathematical language, their ability to work better in a group, their understanding that they learned from each other, and an increase in a positive attitude. In addition to this, it was a successful intervention for boys who find traditional mathematical teaching challenging.

Recommendations

In light of the findings of the study, the following recommendations for practice have been made.

- The curriculum specialists should consider infusing the cognitive conflict approach into the Grade R curriculum to enhance understanding of mathematical concepts. This is necessary because the study reported that using this approach and group work proved successful in this study, particularly for learners who require additional support in the classroom.
- The Department of Education should consider cognitive dissonance approaches for teachers in early year classes. This would equip them with the

necessary skills, which would help them in teaching concepts to the learners. This is because the study reported that the *Let's Think!* programme was successful in improving children's classification abilities. Moreover, the programme also promotes other mathematical concepts such as seriation, causality, time sequence, and spatial perception.

- The study recommends that teacher training colleges and universities incorporate the cognitive dissonance approach into the syllabus for teachers in the foundation phase. This also applies to teachers already in the system, who may not be qualified or who lack the knowledge to facilitate the teaching of math skills. This would ensure that the teacher trainees are equipped with cognitive dissonance skills before they finish their tertiary education.

Limitations of the study

There were two limitations reported in this study. First, children from only one school participated, preventing the findings from being generalised. However, the information obtained by collecting both quantitative and qualitative data has provided an in-depth analysis of the benefits of using *Let's Think!* and its approach. Secondly, the sample group only consisted of boys. Research undertaken by Aunio and colleagues on the early numeracy performance of South African school beginners, using one-way ANOVA on Think Math, indicated that girls and boys were performing equally well. This leads us to believe that the efficacy of the *Let's Think*! programme would be beneficial for both boys and girls, even though the research took place at an all-boys school.

Suggestions for future research

Throughout the duration of this study and the search for related literature, there was a scarcity of research, not only on early childhood education in South Africa, but also on mathematical skills and their implementation. More research is necessary on the use of theory-driven pedagogy at an early childhood level, particularly in South Africa.

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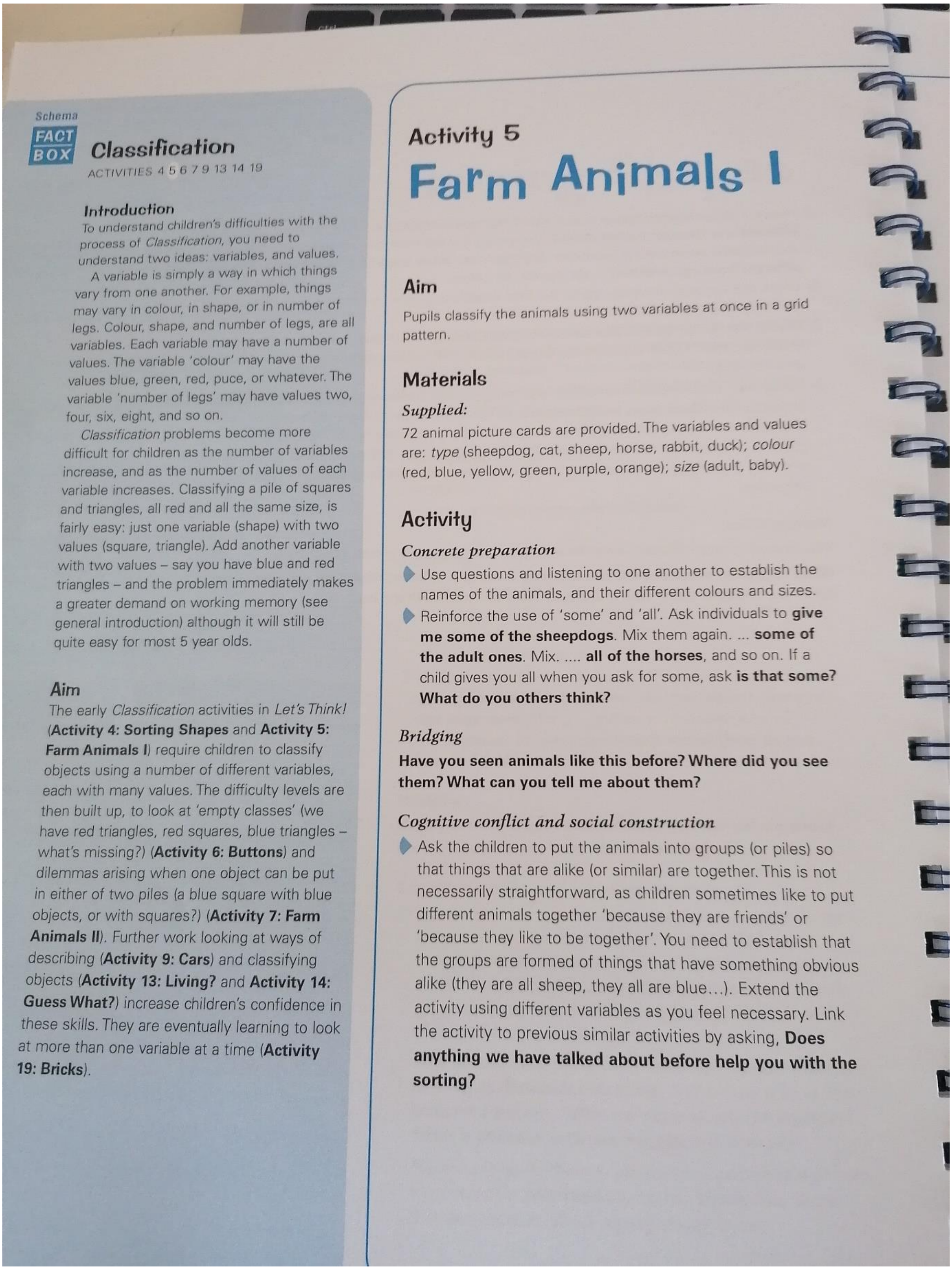
APPENDICES

APPENDIX I: LET’S THINK! LESSON



Schema FACT BOX

Classification

ACTIVITIES 4 5 6 7 9 13 14 19

Introduction

To understand children’s difficulties with the process of *Classification*, you need to understand two ideas: variables, and values.

A variable is simply a way in which things vary from one another. For example, things may vary in colour, in shape, or in number of legs. Colour, shape, and number of legs, are all variables. Each variable may have a number of values. The variable ‘colour’ may have the values blue, green, red, puce, or whatever. The variable ‘number of legs’ may have values two, four, six, eight, and so on.

Classification problems become more difficult for children as the number of variables increase, and as the number of values of each variable increases. Classifying a pile of squares and triangles, all red and all the same size, is fairly easy: just one variable (shape) with two values (square, triangle). Add another variable with two values – say you have blue and red triangles – and the problem immediately makes a greater demand on working memory (see general introduction) although it will still be quite easy for most 5 year olds.

Aim

The early *Classification* activities in *Let’s Think!* (**Activity 4: Sorting Shapes** and **Activity 5: Farm Animals I**) require children to classify objects using a number of different variables, each with many values. The difficulty levels are then built up, to look at ‘empty classes’ (we have red triangles, red squares, blue triangles – what’s missing?) (**Activity 6: Buttons**) and dilemmas arising when one object can be put in either of two piles (a blue square with blue objects, or with squares?) (**Activity 7: Farm Animals II**). Further work looking at ways of describing (**Activity 9: Cars**) and classifying objects (**Activity 13: Living?** and **Activity 14: Guess What?**) increase children’s confidence in these skills. They are eventually learning to look at more than one variable at a time (**Activity 19: Bricks**).

Activity 5
Farm Animals I

Aim

Pupils classify the animals using two variables at once in a grid pattern.

Materials

Supplied:

72 animal picture cards are provided. The variables and values are: *type* (sheepdog, cat, sheep, horse, rabbit, duck); *colour* (red, blue, yellow, green, purple, orange); *size* (adult, baby).

Activity

Concrete preparation

- Use questions and listening to one another to establish the names of the animals, and their different colours and sizes.
- Reinforce the use of ‘some’ and ‘all’. Ask individuals to **give me some of the sheepdogs**. Mix them again. ... **some of the adult ones**. Mix. .... **all of the horses**, and so on. If a child gives you all when you ask for some, ask **is that some? What do you others think?**

Bridging

Have you seen animals like this before? Where did you see them? What can you tell me about them?

Cognitive conflict and social construction

- Ask the children to put the animals into groups (or piles) so that things that are alike (or similar) are together. This is not necessarily straightforward, as children sometimes like to put different animals together ‘because they are friends’ or ‘because they like to be together’. You need to establish that the groups are formed of things that have something obvious alike (they are all sheep, they all are blue…). Extend the activity using different variables as you feel necessary. Link the activity to previous similar activities by asking, **Does anything we have talked about before help you with the sorting?**

- **Two-way classification:** Use only the adult animals for this activity. Ask the pupils if they can arrange all the adult animals on the table so that all the animals of the same *colour* are together *and* all the animals of the same *type* are together. Give them plenty of time to play with different arrangements and the opportunity to come up with the grid idea (see Table 5 below) themselves. This activity is difficult because they have to use two variables at once, type and colour. They may need leading questions from you. They should end up with something like the pattern shown in Table 5. It may be useful to assign a talented child in each group to check the pattern as the other pupils create it. Able children could be encouraged to make the same pattern with the baby animals.

Metacognition

What have we done new this time? How did we use two different ways of grouping animals to make a grid? Could you explain to someone else what you did, what was difficult, how you solved the problem?

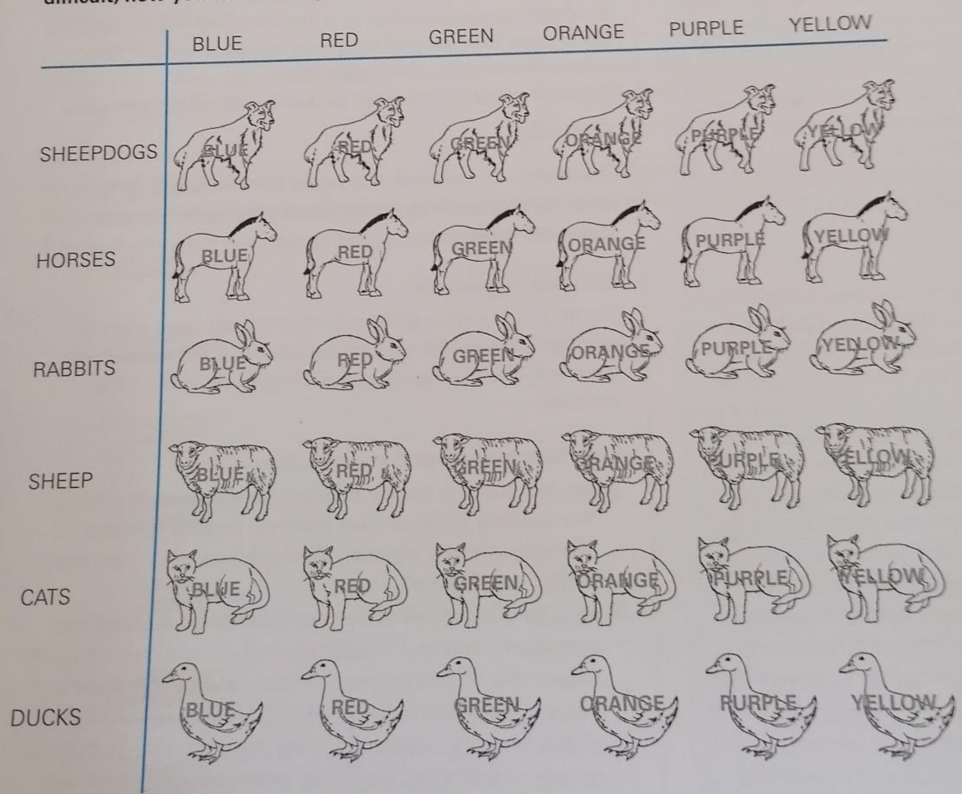


Table 5: An example of a grid that shows classification by two variables

APPENDIX II: PRE-TEST DATA

Pre-test classlists - populated.pdf

APPENDIX III: POST-TEST DATA

Post-test classlists - populated.pdf

APPENDIX IV: OBSERVATION SCHEDULE

What is to be observed?	Procedure / Duration
1. All the boys in the test group - behaviour, cognitive development, friendships	2 days – The groups of 6 boys can be determined in order to ensure their zone of proximal development is similar in each group.
2. Each group of 6 boys	A lesson on simple sorting will be taught in the newly established groups to ensure the groups provide the opportunity for optimal group work, and to cement the relationship with the observer. Each group will take approximately 30 minutes, so 2 hours duration.
3. How each boy in both classes classifies a group of objects • How do they sort first? (according to colour/shape etc.) • Can they sort in more than one way? • Can they sort two variables at the same time?	Each boy will be assessed individually as a pre-test using plastic objects – a collection of dinosaurs. A classlist will be used to record the information.

	It should take about five minutes per child. There are 50 boys, so it would take roughly five hours.
4. The *Let's Think!* Lesson – Farm Animals • Who understands the concept? • Who is the "more knowledgeable other?" • Which children made the connection? • Which children still do not understand the concept?	The lesson will be taught four times to the four different groups for 30 minutes each.
5. Repeat how each boy in both classes classifies a group of objects • How do they sort first? (according to colour/shape etc.) • Can they sort in more than one way? • Can they sort two variables at the same time?	Each boy will be assessed individually as a post-test using plastic objects – a collection of dinosaurs – the same as the pre-test. A classlist will be used to record the information. It should take about five minutes per child. There are 50 boys, so it would take roughly five hours.

APPENDIX V: LETTER REQUESTING PERMSSION FROM SCHOOL

PDF

Letter requesting permission - WHPS.p(

APPENDIX VI: HEADMASTER PERMISSION LETTER

PDF

Headmaster permission letter.pdf

APPENDIX VII: PARENT CONSENT FORM – CONTROL GROUP

Parent Consent form
- CONTROL GROUP-B

APPENDIX VIII: PARENT CONSENT FORM – INTERVENTION GROUP

Parent Consent form
- intervention group.p

APPENDIX IX: CHILD ASSENT FORM – CONTROL GROUP

Child assent form -
Nicola.pdf

APPENDIX X: CHILD ASSENT FORM – INTERVENTION GROUP

Child assent
form-brigette.pdf

APPENDIX XI: PARTICIPATION INFORMATION SHEET – CONTROL GROUP

Participant
Information sheet- CC

APPENDIX XII: PARTICIPATION INFORMATION SHEET – INTERVENTION GROUP

Participant
Information sheet- IN

APPENDIX XIII: ETHICS CERTIFICATE

Hamilton Brigette -
Ethics Certificate.pdf