THE RELATIONSHIP BETWEEN PREFERRED LEARNING STYLES AND PERFORMANCE IN MATHEMATICS OF GRADE FIVE LEARNERS IN WINDHOEK, NAMIBIA

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATIONAL PSYCHOLOGY (GUIDANCE AND COUNSELING)

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ABSTRACT

This study examined the relationship between different learning styles and the performance in Mathematics of Grade 5 learners in Windhoek, Namibia. Moreover, the study investigated gender differences regarding both learning styles and performance in Mathematics. An ex-post facto comparative, as well as a correlational research design, were utilised. Two learning style instruments, a learning style questionnaire and a sensory wiring exercise, were employed to determine the preferred visual, auditory and/or kinaesthetic (VAK) learning style of the learners. The relationship between the learning style research instruments was investigated to determine whether the instruments measured the same preferred learning style. Descriptive and inferential statistics, particularly independent sample t-tests, Pearson's correlation coefficient and a chi-square test for independent samples were employed to analyse the data. Since there was a statistically significant difference in some areas on the learning style questionnaire, the alternative hypothesis with regards to differences in performance in Mathematics among learning styles as measured by the learning style questionnaire can be partially accepted. The results of the sensory wiring exercise, on the other hand, indicate that there was no difference in performance in Mathematics and preferred learning styles of Grade 5 learners in Windhoek. For the sensory wiring exercise, the null hypothesis can be accepted. Furthermore, results indicated no statistically significant difference in either gender or Mathematics and learning styles of the sampled group. Results also indicate no correlation between the two learning style instruments. Research designs other than those employed in this study may offer different results in future research studies regarding preferred learning styles and performance in Mathematics.

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LIST OF ACRONYMS

DNEA	Directorate for National Examinations and Assessments
EAC	Eye Accessing Cues
EMIS	Education Management Information Systems.
ETSIP	Educational and Training Sector Improvement Program
LSI	Learning Style Inventory
LSQ	Learning Style Questionnaire
NIED	National Institute for Educational Development
NLP	Neuro-Linguistic Programming
SACMEQ	Southern and Eastern Africa Consortium for Monitoring Educational Quality
SAT	Standardised Achievement-test
VAK	Visual, Auditory and Kinaesthetic learning styles

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Last but not least, I would like to thank Dr Muller and Eric for their support with the statistical analysis, Dr de Jager for permission to make use of part of her seminal work as a learning style research instrument, and finally, a big thank you goes to my colleagues.

DEDICATION

This research study is dedicated to all Namibian teachers

May you always yearn for more knowledge and understanding

to

teach our Namibian children with passion and dedication.

DECLARATION

I, Catherina Beatrice Viljoen, declare hereby that this study "The relationship between preferred learning styles and performance in Mathematics of Grade five learners in Windhoek, Namibia" is a true reflection of my own research, and that this work, or part thereof, has not been submitted for a degree in any other institution of higher education.

I, Catherina Beatrice Viljoen, grant The University of Namibia the right to reproduce this thesis in whole or in part, in any manner or format, which The University of Namibia may deem fit, for any person or institution requiring it for study and research, providing that The University of Namibia shall waive this right if the whole thesis has been or is being published in a manner satisfactory to the University.

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Catherina Beatrice Viljoen

CHAPTER 1

OVERVIEW

1.1 INTRODUCTION

This study aimed to contribute to local literature by investigating the relationship between learning styles and performance in Mathematics. Chapter 1 deals with the orientation of the study, the statement of the problem, and introduces the research objectives of the study. Next, the null hypotheses are stated, and the significance of the study is shared. This section is concluded with a discussion of the limitations of the study.

Chapter 2 unpacks learning styles and reviews the information processing model as the theoretical framework for this study. The chapter then delves into visual, auditory and kinaesthetic learning styles and reviews previous research on the relationship between learning styles and academic performance, as well as the relationship between learning styles and gender, in the international and Namibian context.

Chapter 3 explains the ex-post facto research design by means of a comparative and correlational study in a quantitative approach. The chapter also discusses the population of the study, the sample, research instruments and procedures, such as the pilot study, as well as data collection and analysis. It concludes with a discussion of the research ethics adhered to, as well as the reliability and validity aspects of the study.

Chapter 4 reports the results obtained from the data collected while Chapter 5 discusses these results and positions the study in the field as related to academic views reported in the literature review. Finally, a summary is presented and concludes with general recommendations and recommendations for further research.

1.2 ORIENTATION OF THE STUDY

Mathematics is a functional and a much-needed element in the economy and society which influence our daily lives. For the past decade, Grade 5 learners' performance in Mathematics has been evaluated by means of Standardised Achievement-Tests (SATs) to evaluate their competency levels. According to the Namibian Directorate of National Examinations and Assessments (DNEA), and, based on the results of the SATs, Namibian Grade 5 learners had been performing substantively low in Mathematics between 2009 and 2014, with national averages being lower than fifty percent. Prior to these years, the low performance in Mathematics of learners who were in Grade 6 was also reported, supported by the outcomes of the Southern African Consortium for Monitoring Educational Quality (SACMEQ) reports, SACMEQ II (Makuwa, 2004), SACMEQ III (Nakashole et al., 2011) and SACMEQ IV (Shigwedha et al., 2017). Although Grade 6 learners' performance had improved by 40 points in the national from an average score of 431 points in 2000 to 471 points in 2007, the performance in Mathematics remained below the expected national average score of 475. Additionally, SACMEQ II, III and IV reports, furthermore, highlighted the differences found in performance in Mathematics between boys and girls. In all three studies, the boys outperformed girls. Substantial evidence has been produced which suggests a historical concern about performance in Mathematics in Namibia based on those SAT and SAQMEC reports. Hence, the results indicating an overall low performance in Mathematics were a cause of concern which initiated further investigation. Consequently, some studies had been conducted in an attempt to investigate factors influencing low performance in Mathematics in Namibia over the past decades (Makuwa, 2004; Nambira et al., 2009; Nakashole et al., 2011; Silas, 2013). Another international study, in which Namibia is unfortunately not part of, is the Trends in International Mathematics and Science Study (TIMMS) which is coordinated by the International Association for the Evaluation of Educational Achievement. This study is conducted every four years, in 64 countries and the target populations are grade 4 and grade 8. Some countries, such as South Africa, administer the TIMMS to different grades such as the fifth and ninth grades. South Africa was a participant to the study in 2015 and 2019. Results indicated South African fifth graders scored significantly lower (374) than what was expected from the mean (500) in the 2019 study. The average in performance in mathematics for South African fifth graders in 2015 was 376. In the 2015 TIMMS study, girls and boys obtained the same mean (both 384), and in 2019, girls (383) outperformed boys (364) in performance in mathematics (Mullis *et al.,* 2019).

Nambira et al. (2009) studied possible reasons for low performance in Mathematics in the Otjozondjupa region and identified a vacuum existing between teaching methodologies and learning styles. The findings pointed out that teachers, when teaching Mathematics, might not accommodate the different learning styles that learners apply in learning Mathematics, and therefore, the accommodation of learning styles was identified as one the factors hindering Namibian learners to perform in

Mathematics. To that end, Nambira et al. (2009) proposed that teaching be adapted to suit the learners' different learning styles, and recommended that future policy reviews should take this matter into consideration. Silas (2013) recommended further research to be conducted in Namibia in order to determine the impact of learning styles on academic performance as he had found supporting evidence that there was an increase in performance in Mathematics when teaching was adapted to suit the learners' different learning styles.

1.3 STATEMENT OF THE PROBLEM

"The Namibian National Standardised Achievement-tests (SATs) are annual assessments administered mainly to provide stakeholders with diagnostic information regarding learners' achievement of key learning competencies in the curriculum in Grades 5 and 7" (Mupupa, 2015, p. 2).

In Grade 5, SATs are written in the subjects Mathematics and English. In Grade 7, SATs are written in the subjects Mathematics, English and Science. The SAT items for Mathematics are based on the Namibian Mathematics syllabus and are compiled and set by the National Institute of Education Development (NIED). Response items of the SATs are coupled to four performance level categories namely *below basic achievement, basic achievement, above basic achievement* and *excellent achievement*. Based on recorded data, the national average scores in percentage for Mathematics were 43% in 2009 (baseline), 43% in 2011, 44% in 2013 and 47% in 2014. An average of 47% implies a score of 18.8 out of 40 for Mathematics. In 2015, there was a substantial improvement of 16% in the national average percentage which implies a score of 25.2 out a total of 40. For Grade 5 Mathematics, the concentration of learners in the lower performance categories (*below basic achievement and basic achievement*) were 88%, 85% and 66% in 2013, 2014 and 2015 respectively (Mupupa, 2015; 2016). A notable decrease in the concentration of learners who scored in the *below basic achievement* and *basic achievement performance* categories was observed from 2014 to 2015; however, the results suggested that approximately two thirds (66%) of the Grade 5 learners scored in the lowest performance categories. In 2016, SATs were not administrated due to curriculum reform and the SATs had to be adapted accordingly to be in line with the revised syllabi and the schemes of assessment for Mathematics, among other reasons. The SATs were resumed in 2017 when items were based on the new curriculum (Mupupa, 2016). SAT results revealed national averages in Mathematics of 49% for 2017 and 54% for 2018. Since the data for this study were collected in 2015 and 2016, the study employed the SATs scores written prior to 2016.

This study acknowledges that several factors, such as teachers' qualifications, teaching styles, nutrition and the learners' emotional well-being may contribute to low performance in Mathematics. Additionally, if a learner is to approach a learning situation where his or her learning style is not catered for, low performance in Mathematics could be expected. Hence, learners' learning styles could account for their low performance in Mathematics. One possible reason for low performance in Mathematics might be attributed to the learners' visual, auditory and kinaesthetic (VAK) learning style preferences which would probably not be considered in the teaching of mathematical content. To the researcher's knowledge, research into visual, auditory and kinaesthetic learning styles and a possible relation to performance in

Mathematics in the senior primary phase is yet to be conducted and documented in Namibia. Based on the latter, the present study's main interest was to determine the relationship between two specific variables, namely preferred learning styles (VAK) and the performance in Mathematics of Grade 5 learners in Windhoek.

Secondly, it is not clear whether different ways of measuring the same phenomenon, namely 'learning styles', would yield similar results. Therefore, this study made use of two different instruments to determine whether both instruments measured the same learning style when determining the participating learners preferred visual, auditory and/or kinaesthetic learning style (VAK). The two instruments utilised were a VAK learning style questionnaire and a sensory wiring exercise (De Jager, 2006; 2009). VAK questionnaires are freely obtainable from the internet (Chislett & Chapman, 2005) although they seem to lack sound psychometric properties, such as validity and reliability. Regardless, VAK questionnaires are commonly employed in educational settings (Franklin, 2006, Sharp et al., 2008). Despite the absence of known psychometric properties, the VAK learning style approach remained the focus in the study.

A secondary interest lay in the soundness of the learning style questionnaire and of the sensory wiring exercise (De Jager, 2006; 2009) in order to identify whether both research instruments measured the same learning style. The sensory wiring exercise have not been employed in formal, local research to determine learners' preferred way of receiving information as input to the learning process. Therefore, this study endeavoured to utilise the sensory wiring exercise as one of the research instruments to contribute to formally documented research in Namibia. Other areas of investigation included differences in performance in Mathematics between boys and girls, as well as differences in the preferred learning styles of boys and girls. To the researcher's knowledge, no similar study has been conducted or documented in the senior primary phase in Namibia. Therefore, the results of this study may be utilised as baseline data for future research. Research regarding the impact of learning styles and academic performance remains an ongoing debate (Geake, 2008; Krätzig & Arbuthnott, 2006; Newton & Miah, 2017; Sharp et al., 2008); hence, this research study was aimed at contributing to current research in this area.

1.4 RESEARCH OBJECTIVES

The research objectives for this research study were:

(i): to determine the preferred learning styles (visual, auditory and kinaesthetic) of Grade 5 learners in Windhoek as measured by both the sensory wiring exercise and a learning style questionnaire;

(ii): to determine the performance in Mathematics of Grade 5 learners in Windhoek;

(iii): to determine the relationship between preferred learning styles (visual, auditory and kinaesthetic) and the performance in Mathematics of Grade 5 learners in Windhoek;

(iv): to determine gender differences with regards to both preferred learning styles (visual, auditory and kinaesthetic) and the performance in Mathematics of Grade 5 learners in Windhoek;

(v): to determine the correlation between the sensory wiring exercise and the learning style questionnaire.

1.5 NULL HYPOTHESES

Research objectives 1 and 2 do not require any hypotheses as both objectives assist the descriptive statistics. The null hypotheses, based on the above research objectives 3, 4 and 5, of the study were:

(i): There is no relation between preferred learning styles (visual, auditory and kinaesthetic) and the performance in Mathematics of Grade 5 learners in Windhoek;

(ii) There is no significant differences between boys' and girls' preferred visual, auditory and kinaesthetic) learning styles and their performance in Mathematics;

(iii): There is no correlation between the sensory wiring exercise and the learning style questionnaire.

1.6 SIGNIFICANCE OF THE STUDY

Dobson (2010, p. 201) noted that "an important consideration of learning theory is the sensory modalities that students prefer to use when internalising information". Thus, by understanding learning styles through the preference of a sensory modality, such as visual, auditory and kinaesthetic (VAK), teachers may be convinced to re-evaluate their methods of instruction when teaching Mathematics. The findings of the study could contribute to current research and may provide baseline data regarding the relationship between preferred learning styles and the performance in Mathematics of Namibian learners for future studies.

This study may shed light on the possible relationship between preferred learning styles and performance in Mathematics and, as a result, may inform future instructional methods for Mathematics based on the preferred learning styles of boys and girls. Ultimately, this may result in possibly improved performance in Mathematics. This study could also shed light on the validity and reliability of the measuring instruments for VAK learning styles employed in this study.

1.7 DEFINITION OF TERMS

For the purpose of this study, the term, learning style, refers to the view that different individuals prefer to process information in different ways and may, therefore, learn more effectively when they receive instruction in a way that conforms to their preference (Pashler, McDaniel and Rohrer as cited in Cuevas, 2015).

Academic performance is defined as a measurable behaviour in a series of assessments, and can be measured at any point in time (Nzesei, 2015).

Preferred learning styles can be measured by employing different instruments, such as inventories or questionnaires. Teachers could possibly utilise learning styles for quality teaching as proposed by Nambira et al. (2009).

1.8 LIMITATIONS OF THE STUDY

Limitations of this study include aspects related to the instruments measuring the visual, auditory and kinaesthetic learning styles. The sensory wiring exercise of De Jager (2006; 2009) does not hold known psychometric properties, such as validity and reliability. However, the exercise has been widely employed in South Africa and Namibia, as well as possibly in other countries, and has been published (De Jager, 2006; 2009) to be utilised by role-players in the educational field. This limitation was mitigated by including an additional instrument to determine the learning styles. The additional instrument utilised was a learning style questionnaire which formed part of training materials for first year students at The University of Namibia, in order to demonstrate visual, auditory and kinaesthetic learning styles. The language level was adjusted to suit the language level of Grade 5 learners. This research instrument was obtained from a lecturer at The University of Namibia. The learning style questionnaire also did not have known psychometric properties, such as validity and reliability.

Further limitations to the study included the schools participating in the study as they were only selected from the group of schools which had completed SATs and whose results were documented by the DNEA in 2013; therefore, results may not yield a true generalisation of the relationship between preferred learning styles and the performance in Mathematics of all Grade 5 learners in Windhoek. The current study acknowledges that various other factors, such as teacher qualifications, teaching styles, parental level of education, parental involvement, motivation, nutrition, language and the child's emotional well-being, may play a role in poor performance in Mathematics (Nambira et al., 2009; Saritas & Akdemir, 2009). This study focused on the individuals' single sensory modality, namely the sensory input of information, as preferred learning style as a possible factor influencing performance in Mathematics.

1.9 CONCLUSION

This chapter presented the orientation of this study, followed by the statement of the problem, research objectives and null hypotheses. Next, the significance of the study was shared and the chapter concluded with the possible limitations of the study. Chapter 2 will deal in depth with the theoretical framework and literature review.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Chapter two deals with controversies prevalent in the literature regarding learning styles. Firstly, the phenomenon of learning styles is discussed, and the chapter then delves into the visual, auditory and kinesthetic learning styles. The section of VAK learning styles is followed by the information processing theory, which forms the theoretical framework of the study.

Subsequently, the researcher reviews previous research on the relationship between learning styles and academic performance. A final discussion of the relationship between learning styles and gender in the international context, and where possible, and Namibia concludes this chapter.

2.2 LEARNING STYLES

The use of the term, learning styles, in education has engendered much controversy (Geake, 2008; Krätzig & Arbuthnott, 2006; Newton & Miah, 2017; Sharp et al., 2008). This controversy stems from different schools of thought and disciplines from which researchers argue or take their stance. According to Coffield et al. (2004, p.1), "[r]esearchers working in the field of learning styles across or within disciplines tend to interpret evidence and theories in their own terms". Along similar lines, Franklin (2006) argues that a common error in learning style research studies is the tendency to draw only on certain aspects of a specific learning theory and then argue, for example, that significant relationships exist between learning styles and academic performances. Based on the literature reviewed for this study, many discrepancies exist in previous studies where researchers have attempted to determine the relationship between learning styles and academic performance. Some researchers found that, when teachers differentiate their teaching style to match a learner's individual learning style, positive and increased academic performance could be expected (Al-Balhan, 2007; Mahdjoubi & Akplotsyi, 2012; Tachie, 2010; Wilson, 2012; Williams et al., 2013). On the other hand, some studies did not find significant correlations between learning styles and the academic performance of learners (Awang et al., 2017; Can, 2009; Krätzig & Arbuthnott, 2006).

As mentioned, learning style approaches and the interpretation thereof depend largely on the discipline from which the researchers argue; therefore, discrepancies are expected. To emphasise the myriad learning theories regarding learning styles, Coffield et al. (2004) reports that more than seventy learning style approaches exist, and discrepancies remain at large. Romanelli et al. (2009) concur with the findings of Coffield et al. (2004) regarding the existence of a myriad of approaches to learning styles and conclude, from their research findings, that no commonly accepted learning style approach currently exists. As relevant stakeholders in education continuously aim for more effective and higher academic performance, learning styles seem to play an important role in education; however, in their critical report, Coffield et al. (2004) warn that one should remain cautious regarding the strengths and weaknesses of different learning styles.

Some studies share the fact that there are inherent strengths in employing learning styles as part of teaching methods. For example, learners experience increased motivation to learn when they understand themselves better in a learning environment. They become better problem solvers and experience increased self-awareness. Furthermore, the ability to sustain attention is more likely to increase (Kazu, 2009; Gilakjani, 2012; Vaseghi et al., 2012). According to Gilakjani (2012), it is more important for learners to be aware of their preferences to adjust study techniques, even when information and instruction do not necessarily match their preferred style.

On the other hand, Newton and Miah (2017) raise the issue that the intended use of learning styles is conceptually flawed, and learning styles in theory, are associated with a number of harms. In their opinion, these harms include issues such as the fact that learners may become overly confident in their ability to master subjects they perceive to match their learning styles; furthermore, resources might be wasted on ineffective methods which have little empirical evidence. Other harms, such as undermining the credibility of educational research or practices and the creation of unrealistic expectations of learners by teachers, should also be kept in mind. Despite the polarity of findings from research studies, a general acceptance still remains that the way in which learners choose to or are inclined to approach a learning situation has an impact on achievement (Cassidy, 2004).

2.2.1 Approaches to Learning Styles

The seminal work of Kolb (1984) and Honey and Mumford (1982) are among many prominent researched methods employed to categorise learning styles in the educational field. The aim of this research was not to critique the different learning styles but, essentially, to recognise that different approaches to learning styles existed. Therefore, before this chapter delves into the VAK learning styles, a brief discussion of these recognised approaches to learning styles will be given.

Kolb's experiential learning approach categorises learning styles as divergers, assimilators, convergers and accommodators. The Learning Style Inventory developed by Kolb and Kolb is employed to measure divergers, assimilators, convergers and accommodators in learning styles. Dixon et al. (1997) explain that the Learning Style Inventory, the instrument to measure these learning styles, is primarily concerned with instructional preferences, thereby utilising information processing as a basis for identifying learning styles. Kolb and Kolb (as cited in Li & Armstrong, 2015) explain that *divergers* reflect on specific experiences from various perspectives whereas *assimilators* develop a theoretical perspective based on specific reflections. *Convergers* are more interested in testing a theory in practice whereas *accommodators* employ the results of that testing as a basis for new learning. Therefore, the match between the learning environment, namely the input of information, and the learning style leads to enhanced learning performance.

As an extension to Kolb's work, Honey and Mumford developed the Learning Style Questionnaire designed to measure intrinsic learning preferences. It places the individual in four categories, namely *activists, reflectors, theorists or pragmatists*. The *activists* enjoy involving themselves in new experiences, tend to be sociable by involving themselves with others in a regular manner, enjoy to centre activities on themselves and experience inflated levels of frustration when activities are associated with implementation and consolidation. *Reflectors* prefer taking a stand back and are more observant in nature. They tend to collect data first and reflect on information given before drawing any conclusions, are cautious and usually take a stand back when involved in discussions. *Theorists,* on the other hand, like to analyse and synthesise information. They like to adapt and integrate observations into complex but logically sound theories. They are keen on basic assumptions, principles, theories, models and the like but experience discomfort when subjective judgments come into play. Lastly, *Pragmatists* enjoy trying out new ideas, theories and techniques in order to establish their feasibility, and are keen on jumping in at the first opportunity in order to experiment with applications. Pragmatists are reported to be practical, down-to-earth individuals; however, they tend to be uncomfortable with open-ended discussions (Duff, 1997).

Learning style approaches, such as that of Kolb and Kolb and Honey and Mumford, are more suitable for mature learners, such as learners in secondary school and beyond. For this reason, the researcher of this study decided rather to look into a VAK learning style approach as it seemed to be more age appropriate for the intended study's age group. VAK learning style questionnaires are widely available and also incorporated into understanding the learning patterns of learners in pre-service teacher training. A discussion of the different visual, auditory and kinaesthetic preferred modes follows next.

2.3 VAK LEARNING STYLES

A well-known and widely researched learning style in the field of education is the visual, auditory and kinaesthetic approach to learning. It is promoted and a well-received approach to understand learning in the classroom by curriculum developers, pre-service and in-service training of teachers (Franklin, 2006). Relevant role players in education find this approach to learning styles attractive as it is simplistic. Regardless of the absence of known psychometric properties, which is not only a limitation in this study but also perhaps in previous research studies, ample VAK questionnaires are available at no cost on the internet for any interested user to download. It seems that VAK questionnaires are consistent in identifying the different learning styles as visual, auditory and kinaesthetic correctly. In such a questionnaire a number of questions are asked to match one of the three sensory modalities (V, A or K) and the learners choose the answer which best suits their preferred learning style. Moreover, the questionnaire allows the participant to choose only one answer per question. The VAK approach to learning styles implies that learners prefer a primary, sensory modality to receive information from the environment; however, many studies have found that learners often prefer bimodal or multimodal learning styles (Alkhasawneh, 2013; Alkhasawneh, Mrayyan et al., 2008; James et al., 2011; Sterling, 2017). Although the objective of the VAK approach is for teachers to identify and be aware of the learner's preferred sensory modality to tailor instruction in the classroom, Alkhasawneh et al. (2008) bring it to the attention of readers that learning styles do not inform teachers of their learners' intelligence but rather assist teachers to understand why learners find some tasks easier than others.

2.3.1 Preference of a Visual Learning Style

Learners who make use of visual cues as a preferred, sensory learning style remember information at best when they are presented with pictures, diagrams, films, demonstrations and symbols (Bradway & Hill, 2004; Felder & Silverman, 1988). The strengths of visual preference for learners are that they see best when they sit in the front of the classroom, benefit greatly from the use of models, posters, DVDs and PowerPoint presentations, as well as appreciate eye contact and appraisal through receiving certificates and other forms of reward (De Jager, 2009). Alternatively, for example, electronic devices, such as Smartboards, iPads and smartphones or YouTube videos, could be added to present information by means of different applications. Moreover, concentration is hampered when few or no visual cues are presented and these learners find it difficult to remember when information was not written down (De Jager, 2009).

2.3.2 Preference of an Auditory Learning Style

Auditory learners benefit from discussions, prefer verbal explanations to visual demonstrations and effective learning takes place when they explain to others (Felder & Silverman, 1988; Bradway & Hill, 2004). According to De Jager (2009), auditory learners benefit from structured lessons, group discussions and sitting in the middle of the classroom. They also enjoy taking part in conversations, and appreciate verbal acknowledgement. On the other hand, auditory learners struggle to concentrate in a noisy environment. They do not always make eye contact and may battle to be quiet as running verbally through information that they receive is important to them.

2.3.3 Preference of a Kinesthetic Learning Style

Lastly, learners who prefer a kinaesthetic learning style require both "information perception (touching, tasting, smelling) and information processing (moving, relating, doing something active while learning)" (Felder & Silverman, 1988, p. 676). De Jager (2009) shares that, in the kinaesthetic learning style, learners enjoy to be seated where there is enough space to move around, such as at the back of the class. They benefit from hands-on learning and appreciate a pat on the back or something tangible. However, these learners "get lost in chalk and talk teaching, often need to move and lose concentration when no movement or hands-on learning is allowed" (De Jager, 2009, p. 39).

According to Sreenidhi and Tay (2017), the VAK approach to learning styles expanded on the earlier Neuro-Linguistic Programming (NLP) approach to eye-accessing cues (EAC). In neurological research, both lateral and vertical eye movement seem to be associated with activating different parts of the brain. In neurological literature, these movements are called lateral eye movements and in NLP it is called eye-accessing cues, as they give insights into the way that people are accessing information (Ellerton, 2004 as cited in Richards, 2013). According to NLP, a person's senses are divided into three groups, visual, auditory and kinaesthetic, which are referred to as internal representational systems. Internal representational systems relate to the notion that the brain utilises senses to build internal representations or model the perception we have of the environment, which in turn refers to the encoding stage of the information processing model. During the 1890s, William James already suspected that internal representations and eye movements might be related. However, it was not until the

1970s that this notion received more attention by Richard Bandler, John Grinder and Robert Dilts (Ellerton, 2004 as cited in Richards, 2013).

The VAK approach to learning styles has been well documented by Fleming since 1987, and forms part of the seminal work by De Jager (2006; 2009). Fleming's contribution to the VAK approach to learning styles and the development of inventories stem from the observations he has made over a decade. He observed, amongst others, that some, who are to be considered excellent teachers, did not manage to reach their learners while less excellent teachers did (Fleming & Baume, 2006). In later years, Fleming added another category to VAK, namely the Read/Write (R) category (Fleming, 2001; Fleming & Mills, 1992). The Read/Write category refers to preference for information printed as words. One of the inherent weaknesses of Fleming's inventory is that it has been critised for its statistical properties as it does not seem to be stable enough to satisfy the necessary criteria of research; yet, it remains an attractive approach to use in education (Riener & Willingham, 2010; Sharp et al., 2008). Despite the debate around the VAK questionnaire's statistical properties, VAK inventories and questionnaires have not been dismissed or forbidden for use.

In her seminal work, De Jager (2006; 2009) did not redesign a VAK questionnaire or inventory but drew attention to an alternative way to a questionnaire or an inventory to determine a learner's preferred visual, auditory or kinaesthetic learning style (see Figures 1, 2, 3 and 4). De Jager developed a programme, Mind Moves, which is a programme available to Mind Move Instructors, occupational therapists, teachers and parents in South Africa and Namibia, and possibly other countries. The design, which

De Jager calls the sensory wiring exercise, draws on the eye-accessing model of NLP and forms an aspect of the Mind Moves programme. De Jager explains that she has made valuable observations and received qualitative validation from clients when clients' preferred learning style was determined by means of the sensory wiring exercise. De Jager found it to be a useful indicator to assist clients with enhancing their way of learning, namely by understanding how information is best received (personal communication, 2014). As De Jager's (2006; 2009) preferred sensory wiring exercise does not include or has a corresponding identification regarding a read/write category, the original VAK approach to learning style is not rejected. As per illustration, the sensory wiring exercise is illustrated next.

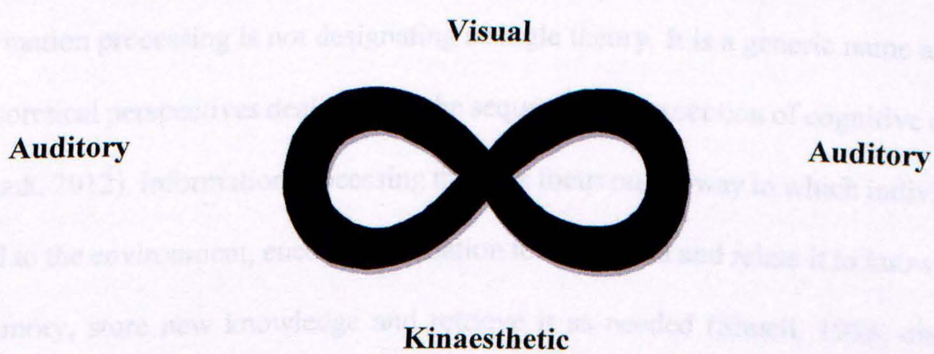


Figure 1: Illustration of the sensory wiring exercise to determine a visual, auditory or kinaesthetic learning style. Adapted from *Mind Moves®: Moves that mend the mind by De Jager, 2009, p. 38.*

VAK questionnaires and inventories mainly focus on determining the dominant, preferred sensory modality; however "[t]he more senses are involved in any experience, the better the quality of learning" (De Jager, 2009, p. 38). From De Jager's point of view, all senses are present at any given moment, but one sense always overrides the other. Markova identified six pattern combinations of visual, auditory and kinaesthetic approaches and refers to these as personal thinking styles (Markova, 1992). The six possible combinations, KAV, KVA, AVK, AKV, VKA, and VAK, imply that the order in which learners prefer to receive information from the environment depends on how well these senses are developed (Al-Balhan, 2007; De Jager, 2005).

The next section deals with the information processing model which forms the theoretical framework of this study.

2.4 THEORETICAL FRAMEWORK: INFORMATION PROCESSING MODEL

Information processing is not designating a single theory. It is a generic name applied to theoretical perspectives dealing with the sequence and execution of cognitive events (Schunk, 2012). Information processing theories focus on the way in which individuals attend to the environment, encode information to be learned and relate it to knowledge in memory, store new knowledge and retrieve it as needed (Shuell, 1986, cited in Schunk, 2012). Furthermore, theorists of the information processing domain consider memory as a filing system that consists of three processes: encoding, storage and retrieval (Papalia et al., 2004).

Encoding information from the environment centres in the sensory memory store, whereas storing of information happens in the short-term memory, alternatively known as the working memory store. Retrieving information takes place in the long-term memory store (Atkinson & Shiffrin, 1971; Weiten, 2001; Woolfolk, 2007).

Encoding is the way in which one transforms a sensory input into a kind of representation which can be placed into memory. Storage refers to the way in which one retains the encoded information in memory, for example, by means of memory techniques; retrieval refers to the way in which one gains access to information stored in the memory (Sternberg, 2009). Since this study focused on the preferred sensory modes of receiving information as a learning style, emphasis was on the encoding process. Therefore, the environmental input refers to visual, auditory or kinaesthetic sensory modalities.

Children have different abilities and preferences in the way they perceive, process and utilise information which, in turn affect, the way in which they learn best (Felder, 2006). According to Lutz and Huitt (2003), new information should be processed into memory in a meaningful way, as it will, otherwise, not be stored as memory. New stimuli come from environmental inputs and the matching of new stimuli is, therefore, essential in the acquisition of new knowledge. Environmental inputs are attended to and received through senses in the encoding process. Each sense has its own sensory registry which holds information in the same way that it is received for a brief period of time; subsequently, the sensory memory is the initial process that transforms incoming stimuli into information so that we can make sense of them (Woolfolk, 2007). Research shares that information is held in that specific sensory registry for only a fraction of a second, where some is lost and some transferred to the working memory (storage) for further processing (Schunk, 2012; Sternberg, 2009; Sternberg & Zhang, 2005). To that end, the interest of this study lay in encoding the information by means of the preferred VAK learning style, and to investigate whether it enhanced performance in Mathematics.

The next section elaborates findings from previous research studies regarding the relationship between learning styles and academic performance. An attempt was made to review studies which investigated specifically VAK learning styles and Mathematics as variables.

2.5 LEARNING STYLES AND ACADEMIC PERFORMANCE

Numerous studies have been conducted employing VAK learning styles and VARK learning styles as independent variables to determine their relationship with academic performance (dependent variable). Research populations that seem to be prominent in research included high school learners (Tachie, 2010; Vaseghi et al., 2013) and undergraduate students from various faculties, such as medicine (Baykan & Naçar, 2007), nursing (Alkhasawneh, 2013; Alkhasawneh et al., 2008; James et al., 2011; Sterling, 2017) and pharmaceutical undergraduates (Williams et al., 2013). Only a few studies focused on Mathematics as the dependent variable and primary school learners as the population. Possible reasons for undergraduates as a popular choice for populations might be that the population and sample are easily accessible when research is conducted. A number of research studies employing VAK learning styles as independent variable have been conducted.

Tachie (2010) conducted a study in Ghana to determine whether visual, auditory and kinaesthetic learning style preferences could be a predictor of academic performance in Science. He made use of a VAK questionnaire as a research instrument. From the sample of 1334 junior secondary high school learners, most of the participants (65%) preferred an auditory sensory modality. Participants who preferred kinaesthetic learning (25%) and visual (10%) styles were in the minority. Tachie (2010) shares that the majority of participants who preferred an auditory learning style were raised in environments with a strong auditory component both at school and at home. Although Vaseghi et al. (2013) did not correlate learning styles to academic performance, they did investigate visual, auditory and kinaesthetic learning style preferences amongst 75 Iranian high school learners. The researchers found that a kinaesthetic learning style took preference over auditory and visual learning styles. Similarly, Vaishnav (2013) also found that kinaesthetic sensory modalities were the most prevalent learning style amongst 200 secondary school learners from the Maharashtra state, which is located in the western region of India. Vaishnav (2013) did, however, correlate learning styles with academic performance, and concluded that a positive correlation existed between kinaesthetic learning styles and academic performance. It should be noted that, from their study, it is not clear which specific subject was the dependent variable. The study merely refers to the dependent variable as academic performance. Other studies conducted in Australia, Jordan and Saudi Arabia also found that a kinaesthetic learning style was the most prevalent and significant choice among nursing students (Koch et al., 2011; Sterling, 2017). Arguments for the prevalence of a preferred kinaesthetic learning style among nursing students include that nursing is a more hands-on course of study. Additionally, in a study conducted in Jordan, Alkhasawneh (2013) found that the learning style preferences of nursing students significantly differed among first, second- and third-year students. His findings were consistent with those of Vorhaus

(2010), who argues that "learning style preferences of students in higher education may shift if the student perceives it necessary to master the learning objectives and needs" (citied in Alkhasawneh, 2013, p. 1548). Therefore, in the future, research interested in learning styles may need to consider longitudinal rather than once-off studies to monitor such provenances.

Al-Balhan (2007) investigated the relationship between performance in Mathematics and learning styles by employing Markova's six combinations of the visual, auditory and kinaesthetic approach to learning. He conducted the study on an experimental and control group of middle school learners. The results demonstrate that knowledge of students' learning styles and appropriate teaching methods improved overall performance in Mathematics in the experimental group when compared to the traditional method of teaching in the control group. The appropriate teaching methods utilised for the experimental group refers to adapting instruction to suit the individual learning style preferences of the learners.

Silas (2013) investigated the effect of learning styles on performance in Mathematics of Grade 11 learners of a secondary school in the Oshana region, northern Namibia. He made use of Kolb's Learning Style Inventory to determine converging, diverging, assimilator and accommodator learning styles and focused on only one aspect of Mathematics, namely Algebra. A post-test was conducted three weeks after the pre-test where learners were taught the same content by employing suitable teaching methods, namely adapting instruction to suit the learners' identified learning style needs. Silas concluded that performance was positively affected after teachers incorporated the learning styles of the learners. Silas (2013) recommended that it would be beneficial if Mathematics teachers become acquainted with knowledge and skills regarding learning styles and integrate these into their methods of teaching mathematical content; additionally, they should provide learners with an array of activities to develop their preferred learning styles further. As the sample for his study was very small, he, furthermore, recommended that a larger sample and more regions should be incorporated when investigating the effect of learning styles on performance in Mathematics in Namibia.

William et al. (2013) recommend that teachers should take the learning style preferences of learners into consideration in order to create an effective learning environment for them. In addition, they point out that further research regarding the debate on any correlation between learning style, academic success and teaching methods is required (William et al., 2013). In their research, which focused on pharmaceutical undergraduates in Australia, they found that learning styles were not a fixed personality trait but "should be viewed as patterns of behaviour based upon an individual's previous life experiences, education values and previously played roles" (William et al., 2013, p.116). One of the research instruments for William et al. (2013) was Kolb's Learning Style Inventory. Moreover, the researchers shared the view that an opportunity should be provided to encourage learners to make use of different learning styles and strengthen non-preferred styles to enhance education. Orhun (2013) investigated the effects of learning styles and performance in Mathematics of high school students and support the above-mentioned notion that learning styles are a potential tool for improved performance in Mathematics. Orhun (2013) also made use of Kolb's Learning Style Inventory and results support those of William et al. (2013) where assimilators were the most identified learning style in the sample. Orhun (2013, p. 1164) suggests that "a teaching method should be decided upon for the students which drive them to use their mental skills in order to find fresh information by themselves." Whereas some research argue that learning styles correlate positively with academic performance when content is taught according to the learners' preferred learning styles, other research studies disagree with this point of view.

From another viewpoint in literature on VAK learning styles, some researchers denote the VAK learning style is a neuromyth as validity and reliability of the psychometric properties of the research instruments are questionable. Riener and Willingham (2010) assert that dimensions such as ability, background knowledge and interest, vary from individual to individual, and are known to affect the learning process. In their opinion, learning styles may "come at the cost of attention to these dimensions" (Riener & Willingham, 2010, p. 34). Franklin (2006) argues that the notion of VAK learning styles is unhelpful to teachers as questionnaires do not necessarily take the individual's context or frame of mind into account, nor does VAK questionnaires give the option for the individual to choose more than one answer. Furthermore, Dekker et al. (2012) remark that it is erroneous to assume that only one sensory modality is involved with information processing, and research has shown that children do not process information more effectively when they are educated according to their preferred learning style (Coffield et al., 2004). Research on the relation between learning styles and academic performance seems to remain controversial and inconclusive. The researcher hopes to provide further information regarding this issue. The last section of the chapter deals with a discussion on learning styles and gender difference.

2.6 LEARNING STYLES AND GENDER

Investigating gender differences in learning style studies are quite prevalent and often forms one of the research questions or objectives. Depending on the type of study conducted, research results differ significantly. Some researchers (Alkhasawneh, 2013; Alkhasawneh et al., 2008, Baykan & Naçar, 2007) found that there were no gender differences with regards to learning styles while others (Dobson, 2010; Levine et al., 1999; Wehrwein et al., 2007) did observe significant differences. As VAK studies among primary school learners are limited, this section will look at some learning styles and gender differences among high school learners and undergraduate students.

According to Tachie (2010), that in Science, Ghanaian female high school learners preferred an auditory learning style whereas male learners were more visually orientated (N=1334). Wehrwein et al. (2007) conducted research among undergraduate physiology students (N=86) at the University of Michigan and found that female students (54.2%) rather preferred a unimodal learning style in contrast to male students (58,3%) who preferred a multimodal approach to learning. From the majority of female students who preferred a unimodal learning style (either visual, auditory or kinaesthetic), kinaesthetic was the preferred choice. According to Arnette (2004), gender differences regarding learning styles rely on the way in which gender roles are regarded to be portrayed in the community. In addition, other factors, such as available resources in the educational setting and in the home environment, are likely to play a role when determining learning styles and gender differences. As discussed earlier, depending on the approach of a subject or course, such as nursing, it is likely to expect conclusive evidence between learning styles and gender differences.

2.7 CONCLUSION

Chapter 2 reviewed learning styles, recognising that various learning styles approaches exist and focusing on the visual, auditory and kinaesthetic learning styles. The literature reviewed, furthermore, demonstrated that debate regarding the relationship between gender and academic performance remains on-going.

This study also intends to contribute to this research domain. The next chapter presents the methodology of the study.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Chapter 3 reviews the research methodology and design, as well as the target population and sample, of the study. It, furthermore, presents an explanation of the research instruments employed, followed by an explanation of the data collection procedures, which includes the pilot study.

A review of the data analysis follows the data collection procedures. The methodology section is concluded with a clarification of aspects of validity, reliability and research ethics as related to this study.

3.2 RESEARCH DESIGN

A research design deals with the way in which data are collected from subjects. The subjects of the study were the learners who completed the learning style exercises and whose Mathematics SAT scores were collected. Bless et al. (2006) point out that the research design refers to procedures employed to guide a researcher in order to validate hypotheses based on the research objectives. This is achieved by drawing conclusions about the relationships between variables (learning styles and performance in mathematics).

Each research study employs a specific research design. This study employed a quantitative approach to research as a systematic investigation of numerical data and their relationship was conducted. According to Coolican (2009), quantification can be defined as the process of numerical measurement. Numerical data collected comprised the learning styles of the participants and SAT scores for Mathematics. The learning styles of participants were measured by means of two research instruments, namely the sensory wiring exercise (De Jager, 2006; 2009) and a learning style questionnaire. These instruments were employed to determine the visual, auditory or kinaesthetic learning style. The performance in Mathematics was measured by the Standardized Achievement-Test and the scores in Mathematics were obtained from the DNEA.

This study employed an ex-post facto, comparative design, also known as a causal comparative design, as well as a correlational design. An ex-post facto research design is described as "a systematic, empirical inquiry in which the scientist does not have direct control over independent variables because their manifestations have already occurred or because they are inherently not manipulable" (Kerlinger cited in Upadhya & Singh, 2008, p. 308). According to Beins and McCarthy (2018, p. 91), the main characteristic of an ex-post facto design is that the "design of the study resembles an experiment, but the variables are not manipulated. Instead, the researcher creates categories based on pre-existing characteristics of participants". The categories created were the scores in Mathematics and the VAK learning styles. The independent variable in this study, over which the researcher had no direct control, was the scores in Mathematics. The researcher had had no input on teaching Mathematics content prior to the learners taking the tests and, therefore, had no control over the way in which they would perform on the SATs. Moreover, the learning styles were already manifested within the participants themselves; the researcher only needed to determine the learning style of each participant. Therefore, the study utilised what already existed and drew on the information presented. According to Cohen et al. (2005), such an exercise is conducted in order to explain the nature of the differences, such as the means or correlations in this study that might exist. Hence, such a research design does not include any form of manipulation by the researcher. Beins and McCarthy (2018) share the advantages of an ex-post facto research design as it includes the elimination of some extraneous factors that may influence behaviour and that the researcher can identify as predictable relationships, even if the researcher does not know the cause of such behaviours. However, as the researcher does not control potentially important variables, one cannot affirm the cause-and-effect relationships for a possible relationship which may or may not exist.

The comparative design was employed to determine the relationship between learning styles and performance in Mathematics, as well as the differences between boys' and girls' performance in Mathematics and the differences in learning styles preferred by boys and girls. In addition to the ex-post facto comparative design, this study employed a correlation design as well, since the study was also interested in determining whether the two learning style research instruments measured the same learning style.

3.3 POPULATION

The sample of the study was drawn from a specific population which constitutes the group or category of people that meet the set criteria for a study (Beins & McCarthy, 2018; Coolican, 2009). The criteria for the population of this study were: (a) schools in Windhoek who enrol Grade 5 learners, (b) schools who make use of the Namibian syllabus as set out by the Ministry of Education and (c) schools whose learners wrote the Mathematics Standardised Achievement-test (SATs) in 2013 and 2014. There were 58 schools who met the abovementioned criteria, thus amounting to 6,587 Grade 5 learners.

3.4 SAMPLE

Two sampling methods were employed to select the sample for the study. Firstly, purposive criterion sampling was utilised to select schools. Purposive sampling implies that the units are chosen on purpose in relation to the set criteria (Fogelman, 2002; Ritchie et al., 2003). "The first aim is to ensure that all the key constituencies of relevance to the subject matter are covered. The second aim is to ensure that, within each of the key criteria, some diversity is included so that the impact of the characteristic is explored" (Ritchie et al., 2003, p. 79). The purposive sampling method was guided by the before-mentioned criteria.

Next, simple random sampling was applied to select individual schools who fulfilled the set criteria. Random sampling is defined as "every case in the target population has an equal chance of selection and so does every combination of cases" (Coolican, 2009, p. 43). The names of all fifty-eight schools that met the criteria for the population were placed in a jar. Next, ten schools were drawn from the jar and numbered one to ten as they were selected. These selected schools were approached for participation in chronological order, namely the school that was drawn first was approached first to take part in the study. This selection process was continued until a sample size of at least 300 learners was reached to ensure a sample size of 5% of the population. Four schools agreed to participate in the study, and as whole class groups were utilised, 469 Grade 5 learners formed the final sample. The sample for this current study was approximately 7.12% of the population. Data (the administration of the learning style questionnaire and the sensory wiring exercise) were collected early the following year, which meant most learners had progressed to Grade 6. The delay in data collection was due to the signatories on formal documentation required from relevant stakeholders to proceed with the data collection process. The data were collected within a three-month period from when the learners had written the Mathematics SATs during November, which included at least a five-week school holiday over the month of December and January. As such, the SATs were written towards the end of the Grade 5 academic school year and the preferred learning styles were determined early in the Grade 6 academic school year of the participants.

Whole class groups were selected to ensure the likelihood of a combination of learning styles and to limit the possibility of learners feeling left out during the data collection. An attempt was made to select a balanced sample of boys and girls since the difference between learning styles and gender and performance in Mathematics and gender per se were also research objectives.

3.5 RESEARCH INSTRUMENTS

Two research instruments, namely the sensory wiring exercise (De Jager, 2006; 2009) and a learning style questionnaire, were employed to determine the visual, auditory and/or kinaesthetic learning styles of the participants. The aim of the learning style questionnaire was to compare whether the same learning style result of each participant was obtained from the sensory wiring exercise. The Mathematics scores, which were based on the third research instrument, the Standardized Achievement-test, were collected from the DNEA.

3.5.1 Sensory Wiring Exercise

The sensory wiring exercise, as was illustrated in Figure 1 in the previous chapter, was utilised to determine an individual's preferred sensory modality, for example visual, auditory or kinaesthetic, as a learning style (De Jager, 2009). The sensory wiring exercise was administered by giving each participant a blank sheet of squared paper, approximately 21 cm each side and a pencil. According to De Jager's observations (personal communication, 2015), squared paper is essential for the exercise as an A4 page in a landscape position could subconsciously guide the learner towards an auditory learning style (Figure 3) and may not reflect the participant's true preferred learning style. The administrator first demonstrated a free-flowing infinity sign laying horizontally on its side, or better known as a lazy eight, in the air. The administrator utilised the midline of the body as a reference point to demonstrate that the infinity sign needed to start from the centre of the sign. Participants were then instructed to use their pencils; they were reminded to start in the middle of the page and complete one free flowing lazy eight.

The infinity sign is scored by drawing a horizontal line through the crossing of the midpoint of the lazy eight. The lazy eight is interpreted by employing the following guidelines and visual examples (see Figures 2, 3 and 4): "When the eight is bigger above the line the eyes turn upward more often, 'clicking on the button' in the brain that access vision. This means the child is a visual learner. When the eight is flat and thin, the eye turns towards the ears clicking on the buttons in the brain to access hearing. This means that the child is an auditory learner. When the eight is bigger below the line it is because the eyes turn downwards to click on the buttons to access awareness of touch and feelings. This means the child is a kinaesthetic learner" (De Jager, 2009, p.38). Examples of the sensory wiring exercise is illustrated below:

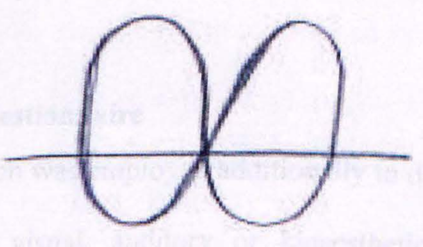


***Figure 2*:** Illustration of a visual preferred learning style on the sensory wiring exercise. Adapted from *Mind Moves®: Moves that mend the mind* by De Jager, 2009, p. 38.

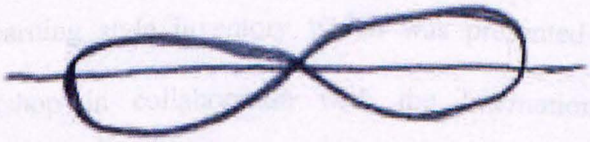


Figure 3: Illustration of an auditory preferred learning style on the sensory wiring exercise. Adapted from Mind Moves®: Moves that mend the mind by De Jager, 2009, p. 38.

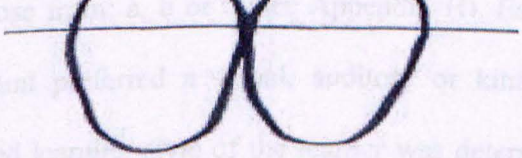


***Figure 4*:** Illustration of a kinaesthetic preferred learning style on the sensory wiring exercise. Adapted from *Mind Moves®: Moves that mend the mind* by De Jager, 2009, p. 38.

The learning style preferences in the sensory wiring exercise were determined by utilising Figures 2, 3 and 4 as guidance. Appendices J, K and L present examples of the sensory wiring exercises for VAK learning styles which were produced by participants during data collection. Combinations such as V/A, V/K and A/K could be achieved if the learner scored exactly the same on two of the learning styles. For the scoring of the sensory wiring exercise, the expertise of an experienced Mind Moves Instructor was consulted.

3.5.2 Learning Style Questionnaire

A second instrument which was employed additionally to determine the participant's learning style, vis-a-vis visual, auditory or kinaesthetic, was a learning style questionnaire. This learning style questionnaire was obtained from a lecturer at The University of Namibia. The questions were guided by a self-understanding activity adopted from a learning style inventory which was presented at a professional development workshop in collaboration with the International Training and Educations Centre for Health. Similar questionnaires to determine an individual's visual, auditory or kinaesthetic learning style are freely available on the internet. This learning style questionnaire consisted of fourteen questions. Each question provided three options to choose from: a, b or c (see Appendix H). Each question indicated whether the participant preferred a visual, auditory or kinaesthetic approach to learning. The preferred learning style of the learner was determined by tallying the most preferred learning style, based on the options chosen by the learner in the questionnaire (Appendix I). Each option would count towards the score of the preferred learning style. The minimum score which could be obtained was 0 and the maximum score was 14. A combination of learning styles, V/A, V/K or A/K could be obtained if the learner scored the exact same total on two of the learning styles. In terms of language, English is the medium of instruction in the schools selected for the sample. The language of the questionnaire was adapted to suit the English language level of a Grade 6 second language learner. The language of the questionnaire was reviewed by two Grade 6 English subject teachers and one Grade 7 English subject teacher. To determine whether the questions of the questionnaire indeed measured the intended visual, auditory or kinaesthetic preference in line with the sensory wiring exercise, the questions were also reviewed and verified by an experienced Mind Moves instructor in Windhoek.

3.5.3 Standardized Achievement-Test (SAT)

The Mathematics Standardised Achievement-test was developed by the Ministry of Education and is based on the mathematical competencies which learners should have mastered at the end of Grade 5. The criteria of the test were based on the Namibian syllabus in use at the point in time of data collection. The score sheets (see Appendix M) were obtained from the Directorate of National Examinations and Assessments (DNEA). Each score sheet provided personal details of the participant as well as an identification number. As the score sheet was marked electronically, only the identification number appeared on the data sheet of the DNEA. Therefore, each participant's name and surname from the sensory wiring exercise and learning style questionnaire had to be matched with their score sheet. Once the identification number of the learner was obtained, the score of the individual could be identified and obtained.

All the data collected from the learning style questionnaire, the sensory wiring exercise and the SAT score were entered onto a summary sheet (see Appendix I) for each learner before the data were entered into Microsoft Excel and Statistical Package for Social Sciences (SPSS) for data analysis.

3.6 PROCEDURE

3.6.1 Pilot study

A preliminary exercise, a pilot study, was conducted to evaluate certain aspects of the research before the study was implemented (Coolican, 2009; Rosnow & Rosenthal, 1996). Aspects which needed to be evaluated was the language of the learning style questionnaire to establish whether it was suited for an English second language learner on Grade 5 level, as well as the time it would take the researcher to explain the assent form, administer the sensory wiring exercise and guide the participants through the learning style questionnaire to ensure all questions were filled in to avoid unnecessary elimination of data for data analysis purposes.

The pilot study was conducted with 56 participants from a school that met the criteria for the population to be selected but was not included in the sample. Minor adjustments, such as the language level, were made.

3.6.2 Data Collection

The researcher visited the sampled schools and administered the sensory wiring exercise and the learning style questionnaire. Each of the four schools that took part in the study allocated a period of at least thirty minutes on the timetable. According to the school's timetable, the researcher visited the full classes on days identified by school management. Each learner received a plastic sleeve, which contained blank squared paper for the sensory wiring exercise, the learning style questionnaire and a pencil. No erasers where allowed.

Upon De Jager's recommendation, the researcher demonstrated the sensory wiring exercise on the black board, without using chalk, as well as drawing an imaginary infinity figure in the air. Each blank squared paper was placed in front of the learners. The class teacher assisted with ensuring that the learners started with the sensory wiring exercise in the middle of the squared paper. Once the sensory wiring exercise was completed, the researcher read the questions (items) from the questionnaire. Each learner had the opportunity to circle a, b or c and thereby indicate their preferred VAK style of learning. The researcher read the questions for the sole purpose of ensuring that the participants did not accidentally miss a question which could have resulted in incomplete data. Next, the score sheets and performance records of the SATs were obtained from the DNEA to match the identification numbers with the learners' particulars, such as their names, surnames and the school. The names were known to the researcher, but additional care was taken to keep all names confidential.

3.7 DATA ANALYSIS

This study made use of both descriptive and inferential statistics. The purpose of descriptive statistics is to describe the set of data collected, for example, utilising graphs or tables to show frequencies. "Inferential statistics consists of techniques that allow us to study samples and then make generalizations about the population from which they were selected" (Gravetter & Wallnau, p. 8, 2013). Therefore, inferential statistics aided in accepting or rejecting the study's hypotheses.

3.7.1 Descriptive Statistics

Descriptive statistics refer to the analysis of data that aid in describing, showing or summarising data in a meaningful way, as well as in gaining an initial impression of the data collected (Terre-Blanche & Kelly, 1999). Descriptive statistics do not, however, allow the drawing of conclusions beyond the data analysed or reaching conclusions regarding any hypotheses made. Data are described in terms of the means, medians, modes and frequencies, where appropriate. Frequencies are commonly employed in descriptive statistics, and represent the number of cases in specific categories (Beins & McCarthy, 2018; Coolican, 2009). The data set was cleaned in such a way that all learners with no SAT scores and those who did not complete the questionnaire or sensory wiring exercise were eliminated. Hence, data was considered when a learner's profile had a complete set of data which comprised of a completed sensory wiring exercise, a completed learning style questionnaire and had a SAT score. Thus, from the original 469 learners, only the data of 385 were utilised for analysis. Hence, the final sample accounted for 5.4 % of the population.

3.7.2 Inferential Statistics

According to Coolican (2009, p. 349), "inferential statistics are procedures for making inferences about whole populations from which samples are drawn". Since a comparative and correlation approach was followed in this study, different statistical analysis, such as independent sample t-tests, Pearson's correlation coefficient (*r*) and the Chi square test of independence, were applied.

The mean Mathematics score per learning style from which the independent sample t-test could be utilised in order to compare the preferred learning styles to the performance in Mathematics of Grade 5 learners (research objective 3) was first determined; it was also employed to determine differences between performance in Mathematics and gender. The Chi-square test of independence was utilised in the statistical analysis to determine the differences between preferred learning styles and gender (research objective 4). Pearson's correlation coefficient (Pearson's *r)* was utilised to determine the correlation between the two preferred learning style research instruments (research objective 5).

3.7.2.1 Independent Samples T-Test

A t-test is a type of inferential statistic employed to determine whether there is a significant difference between the means of groups which may be related in certain features (Beins & McCarthy, 2018). For research objective 3, the study used the t-test for independent samples to determine the difference in mean SAT Mathematics scores of the preferred learning styles. The t-test was also utilised to determine gender differences with regards to learning styles as well as performance in Mathematics (research objective 4). The t-test is one of many tests utilised for the purpose of hypotheses testing in statistics.

The t-test for independent samples is a parametric measure which is utilised to compare the mean scores of different samples and whether they differ reliably from one another (Beins & McCarthy, 2018). Hence, the study determined, for example, whether the mean SAT scores for Mathematics, as calculated per preferred learning style, were significantly different ($p<0.05$) so that when the data collection was repeated, similar results would be yielded. If the p-value was lower than 0.05, the null hypothesis was rejected and if the p-value was higher than 0.05, the null hypothesis was accepted.

3.7.2.2 Chi-Square Test for Independence

The chi-square test for independence is a non-parametric measure which is utilised to compare proportions across two variables, such as whether there is an association between two categorical values. The chi-square test for independence is utilised between two unrelated categorical variables after cross tabulation is presented (Beins & McCarthy, 2018; Coolican, 2009).

Cross tabulation is the term for table of frequencies on levels of a variable by levels of a second variable. For research objective 4, the unrelated categorical variables were the preferred learning styles and gender. The preferred learning styles were assigned in visual, auditory, kinaesthetic categories or a combination thereof. The chi-square test was utilised to determine whether the association in the differences between boys' and girls' visual, auditory, and kinaesthetic learning styles were significant or not.

3.7.2.3 Pearson correlation coefficient (*r*)

Correlation approaches are utilised to investigate the relationships among variables when experimental approaches are not feasible (Beins & McCarthy, 2018). Since two learning style instruments were utilised to determine the preferred learning styles of the participants, it was valuable to investigate the relationship between the learning style questionnaire and sensory wiring exercise (research objective 5). The rationale was that if a learner, for example, preferred a visual learning style on the learning style questionnaire, one would expect the same learner to prefer a visual learning style on the sensory wiring exercise. By running a correlation analysis, utilising Pearson's correlation coefficient (*r*), a parametric measure, a numerical value can be connected to the relationship between the two learning style instruments. Furthermore, the correlation coefficient also allows for measuring the strength of the relationship between the learning style questionnaire and the sensory wiring exercise. A coefficient of a value between -1 and +1 is obtained. A correlation coefficient of +1 indicates that the two variables, which are being measured, are perfectly correlated and suggests that, as one variable increases, the other increases proportionately. In contrast, a coefficient of -1 indicates a perfect negative relationship which suggests that, if one variable increases, the other variable decreases proportionately. A correlation coefficient of 0 indicates no linear relationship at all and suggests that, if one variable changes, the other variable stays the same (Field, 2009).

3.8 VALIDITY AND RELIABILITY

Validity and reliability are important aspects in scientific research. Validity refers to the degree to which the questionnaire/instrument measures what it intends to measure

(Rosnow & Rosenthal, 1996). In this research study, an attempt was made to enhance the face and content validity by means of the review of the questionnaire by Grade 6 and 7 English language teachers. The language was adapted to suit the language level of Grade 5 learners, whose mother tongue may not necessarily have been English. Secondly, the questionnaire was scrutinised by a well-experienced Mind Moves Instructor to ensure that the questions were phrased in such a way that they would correspond to the outcomes of the sensory wiring exercise. Other than personal communication with De Jager (2004) about qualitative observations she made over a number of years using the exercise, no statistics on the validity of the sensory wiring exercise are available.

Reliability refers to the consistency of results obtained if, for example, the same learning style questionnaire is administered at different times (Neuman, 2000). Cronbach's alpha is a measure of scale reliability and can be utilised to assess internal consistency. The internal consistency refers to the degree to which the items, in this case the questions of the questionnaire, measure the same underlying attribute, which refers to the visual, auditory or kinaesthetic learning style (Pallant, 2010). In other words, it determines whether the items of the questionnaire are testing the same attribute reliably. Values can range from 0 to 1, with higher values indicating greater reliability; thus, the general rule of thumb is that a Cronbach's alpha of 0.7 is acceptable. A statistical procedure was utilised to determine the Cronbach's alpha for the learning style questionnaire, by making use of the statistical package, SPSS. The learning style questionnaire consisted of 14 items and the Cronbach's alpha for the learning style questionnaire was 0.756. The reliability of the learning style questionnaire was, therefore, accepted.

3.9 RESEARCH ETHICS

This research study associated itself with ethical guidelines set out by the American Psychological Association (2017). Approval to conduct the research study was granted by the Postgraduate Studies Committee of the University of Namibia (see Appendix A). The UNAM Ethics Committee granted ethical clearance (see Appendix B) and permission was sought from the Permanent Secretary of the Ministry of Education (see Appendix C), as well as from the Directorate of Education of the Khomas Regional Council (see Appendix D).

Research ethics were, furthermore, adhered to by obtaining consent from participating schools (see Appendix E), parents (see Appendix F) and assent from learners (see Appendix G).

In order to maintain confidentiality and anonymity of learners' personal particulars, such as their names, surnames, at which school they were enrolled and the result of their mathematical performance measured by the Standardised Achievement-Test, a study identification number was allocated to each participant to identify him or her throughout the study. This approach ensured consistency in matching data gathered from different instruments. The names were thus known to the researcher, but additional care was taken to safeguard the identities of the participants. Data are to be kept for five years in safekeeping and then shredded.

Participation was voluntary, and both school principals and learners were made aware that they were free to withdraw and discontinue participation at any time, without prejudice. To the knowledge of the researcher, all steps were taken to ensure that no participant was harmed in any way, physically and/or emotionally.

3.10 CONCLUSION

Chapter 3 discussed the research design of the study, the population and sample. Further elaboration of the research instruments, namely the sensory wiring exercise, learning style questionnaire and the mathematics scores of the SATs that were employed, was given.

The chapter, furthermore, presented an insight into the data collection procedures. It concluded with a discussion of the procedures regarding data analysis, validity and reliability, as well as research ethics, to which this study adhered. The next chapter presents the findings.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

This chapter presents the results of the statistical analysis procedures which were followed as described in Chapter 3. The chapter comprises two main sections.

The first section presents the descriptive statistics which contain information such as the demographic information of the sample. The frequencies and percentages of the learning styles and Mathematics scores obtained by the participants are presented as a whole group. The second section presents the inferential statistics where independent sample t-tests, chi square tests for independence and Pearson's correlation were conducted to test the hypotheses of the study. Independent sample t-tests were utilised to determine the relationship between preferred learning styles (VAK) and the scores in Mathematics (SATs) of Grade 5 learners in Windhoek and to determine the difference between boys' and girls' scores (SATs) in Mathematics. The Chi-square test of independence was applied to determine the differences between boys' and girls' preferred learning styles. A Pearson's correlation coefficient was utilised to determine the relationship and the strength of the relationship between the preferred learning style instruments.

4.2 DEMOGRAPHIC INFORMATION

For the main study, data were collected from a total of 469 learners from four participating schools in Windhoek in the Khomas region of Namibia. Additional data were collected from 56 learners of a fifth school for the pilot study. The data collected from the 56 learners for the pilot study were not included in the data analysis as the aim of the pilot study was to correct any errors in the administration of the sensory wiring exercise and learning style questionnaire, as well as to evaluate the level of language of the learning style questionnaire. The data set of 469 was cleaned in such a way that all learners with no SAT scores and those who did not complete the questionnaire or the sensory wiring exercise were eliminated. Thus, from the original 469 learners who participated in the study, the data of only 385 learners were utilised for analysis. Of these, 50.6% were males (N=195) and 49.4% females (N=190).

The schools, selected at random, were located in different socio-economic suburbs in Windhoek. The four participating schools in the main study comprised one private school which ranked 2nd out of the 58 schools who wrote the SATs and three government schools ranking 4th, 31st and 53rd overall in the SATs. One school was located in what was considered a high-income area, one school in a middle-income area and two schools in lower income areas. The following sections reflect the learning styles of the whole group for each of the learning style instruments, as well as the SAT results of the whole group.

4.3 PREFERRED LEARNING STYLES

Participants completed a sensory wiring exercise, as well as a learning style questionnaire, to determine their preferred learning styles (see Chapter 3). Learning styles were categorised as visual (V), auditory (A) or kinaesthetic (K). The results show that some learners did not indicate a single primary learning style preference, but rather a combination of the different styles presented to them. The different combinations of learning styles were identified as V/A, V/K or A/K. Figure 5 shows the percentage of preferred learning styles for each of the learning style research instruments, the learning style questionnaire and the sensory wiring exercise of the whole sample.

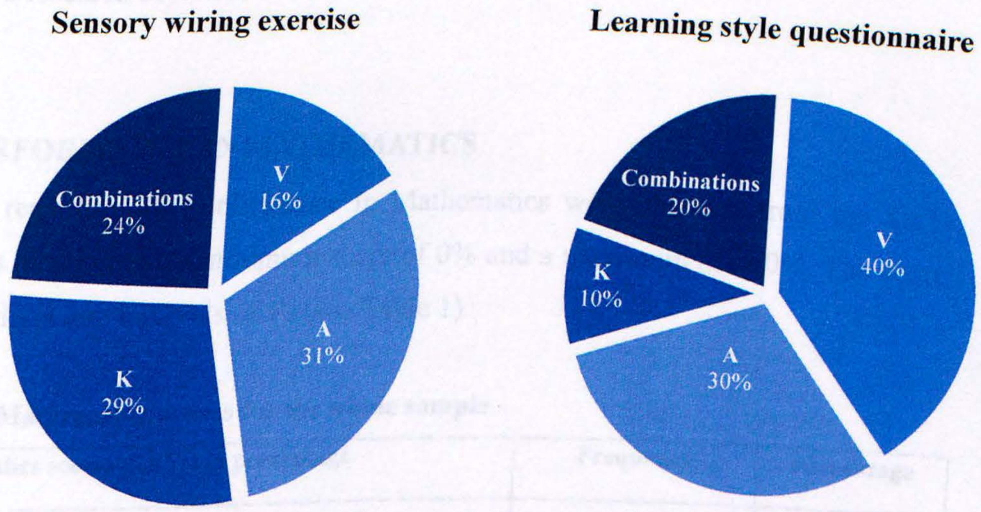


Figure 5: Preferred learning styles measured by the sensory wiring exercise and the learning style questionnaire of the whole sample (N=385).

The results of the sensory wiring exercise indicated that 16% (62) of the learners preferred a visual, 31% (120) an auditory and 29% (111) a kinaesthetic learning style while 24% (92) preferred a combination of learning styles. The results of the learning style questionnaire indicated that 40% (155) of learners preferred a visual, 30% (116) an auditory and 10% (38) a kinaesthetic learning style while 20% (76) preferred a combination of learning styles.

As reflected in Figure 5, the sensory wiring exercise revealed that an auditory learning style (31%) was the most preferred whereas a visual learning style (16%) was the least preferred. Contrasting to the results obtained from the sensory wiring exercise, a visual learning style (40%) was the most preferred choice on the learning style questionnaire with a kinaesthetic approach (10%) being the least preferred choice. The results above focus on research objective 1.

4.4 PERFORMANCE IN MATHEMATICS

Results regarding the performance in Mathematics were obtained from the SATs. Learners could obtain a minimum score of 0% and a maximum of 100%. The scores were divided into intervals of 10 (see Table 1).

Table 1: Mathematics scores for the whole sample

Mathematics scores (SATs) in percentage	Frequency	Percentage
0 – 9	0	0.0
10 – 19	3	0.8
20 – 29	14	3.6
30 – 39	39	10.1
40 – 49	60	15.6
50 – 59	61	15.8
60 – 69	57	14.8
70 – 79	60	15.6
80 – 89	49	12.7
90 – 99	40	10.4
100	2	0.5

N=385

The mean score for Mathematics for the group was 61.5%. Two hundred and seventy (70%) learners obtained a score of 50% or more, with 91 (24%) learners scoring 80% or more. There was uniformity in the distribution between scores of 40% to 49%, 50% to 59% and 70% to 79%, with each 10% interval accounting for almost 16 percent of the learners in the sample. The results above focus on research objective 2. Thus far the chapter has presented the descriptive statistics, such as the preferred learning styles and the scores for Mathematics for the whole group. The following sections deal with the inferential statistics and report on the results of the statistical analyses.

4.5 RELATIONSHIP BETWEEN LEARNING STYLES AND PERFORMANCE IN MATHEMATICS

The main research objective of the study was to determine the relationship between preferred learning styles and performance in Mathematics (research objective 3). The independent sample t-test was applied to determine whether the differences in scores for Mathematics, as was found for the different learning styles (see Table 2), were statistically significant or not. The analysis was conducted for both learning style research instruments.

Table 2: Independent sample t-test results of preferred learning styles and Mathematics

	Learning style	Variable	N	*M*	*MD*	*SD*	*t*	*p*
Sensory wiring exercise	A/V	A	120	63.79	4.05	19.54	1.32	.190
		V	62	59.74		19.91		
	A/K	A	120	63.79	3.77	19.54	1.45	.148
		K	111	60.03		19.85		
	A/COMB	A	120	63.79	.78	19.54	.280	.780
		COMB	92	63.01		20.83		
	V/K	V	62	59.74	-.29	19.91	-.090	.928
		K	111	60.03		19.85		
	V/COMB	V	62	59.74	-3.7	19.91	.972	.333
		COMB	92	63.01		20.83		
	K/COMB	K	111	60.03	-2.98	19.85	-1.04	.298
		COMB	92	63.01		20.83		
Learning Style Questionnaire	A/V	A	116	57.70	-6.26	20.35	-2.59	.01**
		V	155	63.96		19.18		
	A/K	A	116	57.70	-4.14	20.35	-1.07	.287
		K	38	61.84		21.93		
	A/COMB	A	116	57.70	-6.28	20.35	-2.12	.035*
		COMB	76	63.97		19.53		
	V/K	V	155	63.96	2.12	19.18	.593	.554
		K	38	61.84		21.93		
	V/COMB	V	155	63.96	-0.12	19.18	-.005	.996
		COMB	76	63.97		19.53		
	K/COMB	K	38	61.84	-2.13	21.93	-.527	.599
		COMB	76	63.97		19.53		

COMB = combination of learning styles (V/K, V/A or A/K)
*p<0.05
N=385

The mean scores for Mathematics across the different learning styles on the sensory wiring exercise for the total sample were generally relatively small. The largest mean difference of 4.05 for Mathematics was found between a visual (*M*=59.74, *SD*= 19.91) and an auditory learning style (*M*=63.79, *SD*= 19.54), However, this difference was not statistically significant ($p>0.05$.). Furthermore, no statistically significant differences were found amongst any of the preferred learning styles and the mean scores for Mathematics on the sensory wiring exercise.

The differences in the mean scores for Mathematics across the different learning styles on the learning style questionnaire were slightly higher than on the sensory wiring exercise. The largest mean difference of 6.27 for Mathematics was found between an auditory learning style (*M*=57.70, *SD*= 20.35) and a combination of learning styles (*M*=63.97, *SD*= 19.53), $p<0.05$. Those learners with a combination of learning styles thus outperformed those with an auditory learning style in Mathematics. Similarly, a mean difference of 6.26 for Mathematics was found between a preferred visual learning style (M=63.96, SD=19.18) and an auditory learning style (M=57.70, SD= 20.35), $p<0.05$, with the visual learning style showing a higher performance in Mathematics. These two differences were thus relatively big and also statistically significant ($p<0.05$).

Since there was a statistically significant difference in some areas of the learning style questionnaire, the alternative hypothesis can be accepted partially with regards to differences in performance in Mathematics among learning styles as measured by the learning style questionnaire. The results of the sensory wiring exercise, on the other hand, indicated that there was no difference in the performance in Mathematics and preferred learning styles of Grade 5 learners in Windhoek. For the sensory wiring exercise, the null hypothesis can be accepted.

4.6 GENDER DIFFERENCES

The previous sections in this chapter dealt with preferred learning styles and the performance in Mathematics of learners for the whole group. The study was interested in determining the difference in learning styles and performance in Mathematics by gender (research objective 4). The sections below deal with learning styles and performance in Mathematics disaggregated by gender.

4.6.1 Learning Styles and Gender

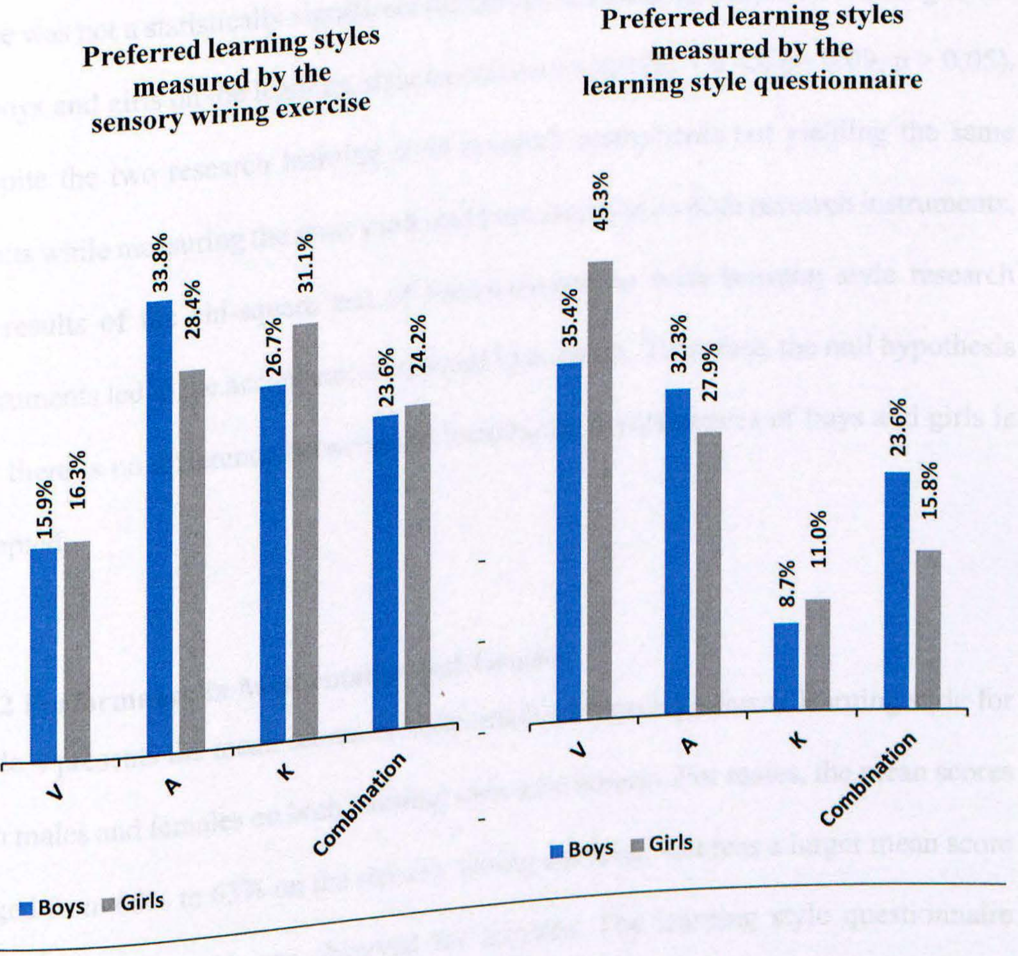
In this study, an attempt was made to sample a balanced number of boys (N=195) and girls (N=190). Table 3 presents the preferred learning styles by gender for each of the learning style instruments.

Table 3: Preferred learning style by learning style instrument and gender

			V		A		K		Combinations	
		N	**f**	**%**	**f**	**%**	**F**	**%**	**f**	**%**
Sensory wiring exercise	**Male**	195	31	15.9%	66	33.8%	52	26.7%	46	23.6%
	Female	190	31	16.3%	54	28.4%	59	31.1%	46	24.2%
Learning style questionnaire	**Male**	195	69	35.4%	63	32.3%	17	8.7%	46	23.6%
	Female	190	86	45.3%	53	27.9%	21	11.0%	30	15.8%

N= 385

Results obtained from the sensory wiring exercise indicated that the auditory learning style was the most preferred by both males (33.8%) and females (28.4%), and a visual learning style was the least preferred by both males (15.9%) and females (16.3%). Contrastingly, the learning style questionnaire yielded quite different results. The learning style questionnaire indicated that a visual learning style was the most preferred by both males (35.4%) and females (45.3%) and a kinaesthetic learning style the least (males 8.7% and females 11.0%). Table 3 is also presented graphically in Figure 6 for more clarity.



N= 385

Figure 6: Preferred learning styles measured by learning style research instruments for gender

The Chi square test for independence was utilised to determine whether the difference between gender and preferred learning styles was statistically significant. Since gender has two categorical values, male and female, and the preferred learning styles had categorical values, VAK and combinations thereof, the Chi-square test for independence was appropriate.

The results obtained indicated that there was not a statistically significant difference between the preferred learning styles of boys and girls on the sensory wiring exercise (χ^2 (3) = 1.58, p= 0.67, hence p> 0.05). Similarly, the results obtained indicated that there was not a statistically significant difference between the preferred learning styles of boys and girls on the learning style questionnaire (χ^2 (3) = 6.45, p= 0.09, p > 0.05). Despite the two research learning style research instruments not yielding the same results while measuring the same preferred learning style on both research instruments, the results of the chi-square test of independence on both learning style research instruments led to the acceptance of the null hypothesis. Therefore, the null hypothesis that there is no difference between the learning style preferences of boys and girls is accepted.

4.6.2 Performance in Mathematics and Gender

Table 4 presents the mean scores in Mathematics for each preferred learning style for both males and females on both learning style instruments. For males, the mean scores ranged from 60% to 63% on the sensory wiring exercise, whereas a larger mean score range of 58% to 65% was observed for females. The learning style questionnaire indicated that the mean scores for males ranged from 56% to 67% across learning styles, while for females the mean scores ranged from 59% to 65%.

The highest mean score for Mathematics was obtained for an auditory learning style (63%) and the lowest for a kinaesthetic learning style (60%) for males on the sensory wiring exercise. Similarly, for females, the highest mean score for Mathematics was also for an auditory learning style (65%). The lowest mean score for Mathematics for females on the sensory wiring exercise was for a visual learning style (58%).

Table 4: Mathematics SAT means for each preferred learning style learning style instrument and gender

	Sensory wiring exercise		**Learning style questionnaire**	
	Male	**Female**	**Male**	**Female**
	SAT Mean %	**SAT Mean %**	**SAT Mean %**	**SAT Mean %**
V	61	58	62	65
A	63	65	56	59
K	60	60	62	62
***Comb**	62	64	67	59
Average	61	62	61	62

N = 385

***Comb = Combination of learning styles**

Regarding the learning style questionnaire, the highest mean score for Mathematics was obtained for a combination of learning styles (67%) and the lowest for an auditory learning style (56%) for males. On the other hand, the highest mean score for

Mathematics for females was for a visual learning style (65%) and the lowest for both an auditory and a combination of learning styles (59 %).

The difference between boys' and girls' mean performance in Mathematics was analysed by an independent samples t-test to determine whether the differences were statistically significant. The results obtained indicated that there was not a statistically significant difference between the mean scores for Mathematics of male learners (*M*= 61.48, *SD*= 19.51) and female learners (*M*= 62.26, *SD*= 20.55), $p>0.05$. Moreover, a very small mean difference of 0.78 for Mathematics was found between males and females, where females had a slightly higher mean score. Based on the results, the study, therefore, accepts the null hypothesis that there is no difference in performance in Mathematics between boys and girls.

4.7 CORRELATION BETWEEN THE LEARNING STYLE RESEARCH INSTRUMENTS

When employing two research instruments to measure the same attribute, such as the VAK learning styles, one would presume that both instruments indeed measure the same attribute (research objective 5). When a comparison was made by tallying the number of VAK and a combination of learning styles on each of the learning style research instruments, a variance in the total number of measured learning style per instrument was observed (see Table 5). For example, the frequency Table shows that 54 learners indicated that they preferred a kinaesthetic learning style on the sensory wiring exercise; however, the same 54 learners indicated that they preferred a visual learning style on the learning style questionnaire. Another example comprises 18 learners who indicated that they preferred a visual learning style on the sensory wiring exercise, but when the results of the learning style questionnaire were reviewed, the same 18 learners preferred an auditory learning style.

The frequency Table indicates that only 20 learners preferred a visual learning style on both the sensory wiring exercise and the learning style questionnaire. Only 43 responses matched an auditory learning style on both learning style instruments; 19 responses matched with a kinaesthetic learning style and only 18 learners' responses matched the combination of learning style preference on both learning style research instruments.

Table 5: Frequencies of learning styles measured by the sensory wiring exercise and the learning style questionnaire.

		Sensory wiring exercise				
		V	**A**	**K**	**Combination**	**Total**
Learning style questionnaire	**V**	**20**	41	54	40	155
	A	18	**43**	27	28	116
	K	3	10	**19**	6	38
	Combination	21	26	11	**18**	76
Total		62	120	111	92	385

N=385

The Pearson correlation coefficient was then applied to determine the relationship between the sensory wiring exercise and the learning style questionnaire. The results indicated (see Table 6) a correlation coefficient (r) of -0.022. This indicates that the correlation between the two research instruments was almost zero and one can conclude that there is no correlation between the two research instruments (r = -0.022). Furthermore, the correlation was also not statistically significant (p >0.05). This study, therefore, accepts the null hypothesis that there is no correlation between the learning style questionnaire and the sensory wiring exercise.

Table 6: Correlation of learning styles between the sensory wiring exercise and the learning style questionnaire

Correlation of the learning style research instruments			
		Sensory wiring exercise	**Learning style questionnaire**
Sensory wiring exercise	r	1	**-.022**
	Sig. (2-tailed)	.665	.665
	N	385	385
Learning style questionnaire	r	**-.022**	1
	Sig. (2-tailed)	.665	.665
	N	385	385

N=385

4.8 CONCLUSION

Chapter 4 presented the descriptive and inferential statistics of the data collected for each of the research objectives. Due to the different types of variables of the study, VAK and combination of learning styles, different learning style research instruments, gender and performance in Mathematics, different types of statistical analysis had to be utilised. The final chapter presents an in-depth discussion of the results obtained and answers the earlier stated hypotheses in more detail.

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

Chapter 5 is a discussion of the results presented in Chapter 4, and is guided by the research objectives of this study. Firstly, the main purpose of this study was to investigate the relationship between preferred learning styles (VAK) and the performance in Mathematics of Grade 5 learners in Windhoek. The study also investigated the gender differences with regards to learning styles and performance in Mathematics. As it is not clear whether the different ways of measuring the same phenomenon, learning styles, would yield similar results, the researcher was interested in the relationship between the two learning style research instruments employed to determine the preferred learning styles of the learners.

Each of the research objectives are discussed and the respective hypotheses are evaluated. Furthermore, the chapter concludes with a discussion of the limitations which presented themselves during the course of the study and the recommendations which are based on the outcomes of this research study.

5.2 LEARNING STYLES

Polarity in the points of view regarding the approaches to learning styles and their relationship with academic performance are prevalent in the literature. Due to the fact that literature in the Namibian context on this topic is limited, this study had to rely on literature from the international context. Whereas some researchers put forth that a positive relationship exists between learning styles and academic performance, inferring a potential cause-effect relationship (Al-Balhan, 2007; Mahdjoubi & Akplotsyi, 2012; Tachie, 2010; Wilson, 2012; Williams et al., 2013), other researchers, such as Awang et al. (2017) and Can (2009), found no relationship between learning styles and academic performance. Further viewpoints include that approaches to learning styles should rather be seen as a neuromyth while other views conclude that approaches to learning styles are merely tools to be employed in gaining an understanding of the ways that learners access information.

Although it was not the intention of the study to investigate combinations of preferred learning styles, the results allowed the researcher to draw some inferences about preferred VAK learning styles. The possible combinations of preferred learning styles discovered during data analysis were V/A, V/K and A/K. To be able to be identified as selecting a combination of preferred learning styles in this study, the particular participant had to score an equal number for two particular learning styles (V, A, and/or K) in the learning style questionnaire. A combination of learning styles could be obtained on the sensory wiring exercise if the drawing was of equal proportion for two learning styles. The combination of learning styles accounted for 20% in the learning style questionnaire and 24% in the sensory wiring exercise. Moreover, combinations of VAK learning styles accounted for at least a fifth of the sample. According to De Jager (2009), combinations of preferred learning styles are possible, but one sense always overrides the other. The results for this particular study do not support the same view. In fact, the results show that some learners preferred a multimodal learning style as suggested by previous researchers (Alkhasawneh, 2013;

Alkhasawneh et al., 2008; James et al., 2011; Markova, 1992 and Sterling, 2017). Furthermore, it is interesting to note that Franklin (2006) points out that learning style questionnaires show a limitation as they do not give the individual the option to choose more than one answer and, therefore, can oversimplify the learning style choice. From observations in this study, it became clear that even though learners could only choose one option per answer, a combination of learning styles still presented itself. Regardless, let us delve into the unimodal learning style preferences.

Based on the learning style questionnaire most learners were in favour of a visual learning style. It was a challenge to find previous literature that indicate a visual learning style as the most preferred choice. The literature reviewed rather found kinaesthetic or auditory learning styles to be the most preferred choice (Koch et al. 2011; Sterling, 2017; Tachie, 2010; Vaishnav, 2013 and Vaseghi et al., 2013). The learning style questionnaire, furthermore, revealed a kinaesthetic approach to learning was the least preferred learning style, which is contrary to the findings of Vaseghi et al (2013) and Vaishnav (2013), who found a kinaesthetic learning style to be the most preferred learning style. Other international studies conducted in Austria, Jordan and Saudi Arabia found a kinaesthetic learning style to be the most prevalent choice (Alkhasawneh, 2013; Koch et al., 2011; Sterling, 2017). A possible reason for a preferred kinaesthetic approach to learning, as mentioned in the literature, is the academic course or content, which acted as the dependent variable, followed by more hands-on, approaches such as nursing. Results of the sensory wiring exercise revealed that the most prevalent learning choice was an auditory learning style, which corresponds with the findings of Tachie (2010). Similar to the findings of Tachie

(2010), a visual learning style was also the least preferred learning style in the sensory wiring exercise.

It became clear from the results that discrepancies existed between the two learning style instruments with regards to most and least preferred learning styles. This raises questions about the validity and the reliability of the two learning style instruments.

5.3 THE RELATIONSHIP BETWEEN PREFERRED LEARNING STYLES AND PERFORMANCE IN MATHEMATICS.

As previously mentioned, research is inconclusive regarding the relationship between learning styles and performance in Mathematics. Based on the analysis of the data collected in this study, in the independent sample t-test analysis no statistically significant differences were observed between preferred learning styles and performance in Mathematics when employing the sensory wiring exercise. Therefore, the null hypothesis, namely that there is no relation between preferred learning styles and Mathematics, can only be accepted for the sensory wiring exercise. Contrastingly, statistically significant differences were found between the scores in Mathematics for both V/A, and A/Comb in the learning style questionnaire and, therefore, the alternative hypothesis can partially be accepted since the learning style questionnaire indicated that there was some relationship between learning styles and the performance in Mathematics of Grade 5 learners in this sample. Additional research is required to investigate why statistically significant differences were found in the learning style questionnaire but not in the sensory wiring exercise.

As literature offers little in terms of VAK preferences and performance in Mathematics, specifically, for Grade 5 learners, a broader approach was followed when the literature was reviewed. Most of the research studies reviewed fall outside the Namibian context. To the knowledge of the researcher, only one similar study (Silas, 2013) about learning styles and academic performance was conducted in Namibia. However, only some inferences could be drawn from his study since Silas (2013) made use of Kolb's Learning Style inventory and also followed a different methodological approach. Nevertheless, the findings of research objective three support the findings of Can (2009), namely that there is not enough conclusive evidence from the VAK learning style instruments employed in this study to generalise a positive relationship between preferred learning styles and academic performance. On the other hand, literature does indicate that, when teachers differentiate their teaching style to match their learners' individual learning styles, a positive academic performance could be expected (Al-Balhan, 2007; Mahdjoubi & Akplotsyi, 2012; Tachie, 2010; Wilson, 2012; Williams et al., 2013).

Since different methodological approaches were followed in learning style research studies, it could account for the many discrepancies that exist in the literature. For example, some researchers made use of control and experimental groups. For a critical review of possible reasons for discrepancies between this research study and other previous research studies, it might be considered that researchers tend to draw only on certain aspects of learning theories (Franklin, 2006). This might have been the case in this study as more elaborate models of VAK learning theories exist, such as VARK (Fleming & Mills, 1992) or a combination of the thinking styles such as VAK, VKA, AVK, AKV, KVA and KAV, as Markova (1992) refers to. Regardless of the variations in methodological approaches in the literature, the findings suggest that there is no conclusive evidence when teaching is tailored to the preferred learning styles of learners' performance in Mathematics. The encoding process, or the way an individual prefers to receive information, may be much more complex with mathematical content than we have perhaps been led to believe.

5.4 GENDER DIFFERENCES

It is quite common in research studies to elaborate differences found between boys and girls; thus, investigating gender differences in learning style research studies are prevalent. As mentioned earlier, academic literature in Namibia regarding learning styles and performance in Mathematics in the primary school is limited. Consequently, the researcher had to review studies conducted in the international context. As previously mentioned, depending on the type of research conducted concerning the dependent variable, research results differ significantly. This section will look at both learning styles and gender differences, as well as performance in Mathematics and gender differences.

5.4.1 Learning Styles and Gender

Another quite common research area or research objective in learning style research is to investigate whether there are differences in preferred learning styles between boys and girls. Depending on the type of learning style research conducted, research findings in the literature differ significantly. Some researchers (Alkhasawneh, 2013; Alkhasawneh et al., 2008; Baykan & Naçar, 2007) have found that there were no gender differences with regards to learning styles while others (Dobson, 2010; Levine et al., 1999; Wehrwein et al., 2007) did observe significant differences.

Results on the sensory wiring exercise indicated that most boys (33.8%) preferred an auditory learning style whereas most girls (31.1%) preferred a kinaesthetic approach. Along similar lines, Wehrwein et al. (2007) also observed in their study that females rather preferred a kinaesthetic approach to learning. Opposing results were observed when we look at the learning style questionnaire. The learning style questionnaire revealed that both boys and girls rather preferred a visual learning style (35.4% and 45.3% respectively) while a kinaesthetic approach to learning was the least preferred by both genders (8.7% and 11.0% respectively). Tachie (2010) reports findings from his study that also indicate males to be more visually orientated. Unfortunately, the results of this study do not support his findings where females were found to be more inclined to an auditory learning style. The Chi-square test of independence was employed to determine whether these differences in learning style preferences between boys and girls were statistically significant. In addition to the two research instruments not yielding the same learning style preferences, the results of the chi-square test of independence indicated that the differences between boys' and girls' learning style preferences were not statistically significant.

According to Arnett (2004), gender differences regarding learning styles rely on the way that gender roles are portrayed in the community. We have seen from the literature that the learning style preferred by boys and girls differs in different developmental stages. For example, learning style preferences of individuals change over time as they adapt to the course content (Koch et al., 2011; Sterling, 2017). In addition, other factors, such as available resources in the education setting and in the home environment, are likely to play a role when determining the learning styles of boys and girls.

5.4.2 Performance in Mathematics and Gender

As mentioned earlier, academic literature in Namibia regarding learning styles and performance in Mathematics in the primary school is limited and, therefore, the researcher had to review studies conducted in the international context. As previously mentioned, depending on the type of research conducted, research results differ significantly. When we look at the Mathematics SAT mean scores of boys and girls, girls slightly outperformed boys, which in comparison, is the opposite of what was found by the SACMEQ II and III reports. In both SACMEQ II and III reports, boys outperformed girls.

Schools generally endeavour to maintain a balance between boys and girls in whole class groups. Since whole class groups were selected in this study, it allowed the researcher to select a balance of boys (N195) and girls (N=190) in the sample. A SAT mean difference of 0.78 for Mathematics were found between boys and girls. The SAT mean score for Mathematics for girls was slightly higher. To investigate whether this difference was statistically significant, the independent sample t-test was applied. The result obtained indicated that the mean difference between mathematics SAT scores of boys and girls was not significant ($p > 0.05$). This study, therefore, accepts the null hypothesis that there is no difference in the performance in Mathematics between boys and girls.

5.5 THE RELATIONSHIP BETWEEN THE RESEARCH INSTRUMENTS DETERMINING LEARNING STYLES

Two learning style research instruments were employed with the intention to determine whether they both measured the same learning style preference. When the researcher reviewed the initial intention of the study to identify only one preferred learning style from each participant, the results indicated that the learning style instruments identified different learning style preferences for large numbers of the sample. For example, when the learner preferred a visual learning style on the learning style questionnaire, it was observed that the result indicated that the learner did not necessarily show the same preference based on the sensory wiring exercise. The frequencies showed that only 20 visual, 43 auditory, 9 kinaesthetic and 18 combination of learning styles corresponded on both learning style instruments.

The Pearson's correlation coefficient allowed for analysis of the nature of the relationship between the two learning style instruments. Results obtained revealed a correlation coefficient close to 0 (r= -.022), which suggests a minimal, negative, linear relationship between the two instruments. The null hypothesis is, therefore, accepted for research objective five which holds that there is no correlation between the results from the learning style questionnaire and the sensory wiring exercise.

A possible reason for variation in results obtained from the two learning style instruments could be because of the instruments' reported lack of validity and reliability properties. The statistical properties or lack thereof of VAK questionnaires have been critised in the literature (Riener & Willingham, 2010; Sharp et. al, 2008). In this research study, cautionary measures were taken to evaluate the reliability of the questionnaire by involving a Mind Moves instructor in evaluating the learning style measured by each question, in order to determine whether a similar response could be expected from a Mind Moves approach; however, the results indicated that the preferred learning styles on each of the instruments did not match each other. One should possibly question the face validity of the questions and ask whether the researcher might have been overly confident about the face validity of the items. However, additional analysis for internal consistency were conducted by employing Cronbach's alpha (0.756) of the questionnaire which suggested the items on the questionnaire indeed measured that intended attribute it was supposed to measure; however, when the two instruments were correlated, it did not yield similar results which puts specifically the reliability of both instruments into question. This serves as a reminder that researchers who make use of research instruments freely available on the internet may have a false confidence regarding the validity and reliability of such learning style questionnaires. The statistical properties of the sensory wiring exercise are yet to be determined.

Another question that comes to mind is whether the instruments were actually testing what they were supposed to be testing or whether the theory behind the instruments was perhaps conceptually flawed, as pointed out by Newton and Miah (2017). These types of queries cast some doubt on the theoretical frameworks of the VAK learning styles research instruments and whether the tendency to draw on only certain aspects of learning theories (Franklin, 2006) is enough to draw definitive conclusions, in other words, generalising that there is a relationship between learning styles and academic performance. Perhaps research of learning style theories should be revisited and different questions should possibly be asked when conducting research. To that end, this study questions the soundness of the validity and reliability of both VAK learning style research instruments employed in this study, but can only report on what was observed. It could also be that unaccounted errors occurred in the scoring of the sensory wiring exercise due to the complex nature of the scoring. Some human error in the determining of the exact preferred learning style on the sensory wiring exercise could have occurred.

5.6 LIMITATIONS

As with the majority of studies, the design of the current study is subject to certain limitations. A serious limitation of this study is the soundness of psychometric properties of the learning style research instruments. To the knowledge of the researcher, no known psychometric properties are available for visual, auditory and kinaesthetic research instruments; nevertheless, VAK learning style instruments are extensively employed in research, as well as by pre-service and in-service teachers and educational institutions. Moreover, the possibility of interpretation in the scoring of the sensory wiring exercise should be kept in mind.

Finally, delimitations in this study included that only Grade 5 learners were selected from 4 schools in the parameters of Windhoek, which limits the generalisability of the findings to all Grade 5 learners.

5.7 RECOMMENDATIONS

Having taken the above-mentioned limitations into account, and based on the research findings of this study, the researcher recommends the following for future research:

- Mathematic performance is influenced by more than just a learning style preference. Other factors for possible poor performance in Mathematics in Namibia should be investigated as literature in the Namibian context is very limited. The international context is not always applicable in a local context as cultures, upbringing and the home environment vary from country to country, as well as from region to region within Namibia.
- Further investigation should be conducted to determine soundness in the psychometric properties of learning style instruments, including both learning style questionnaires and the sensory wiring exercise.
- Educators and other professionals should be cautious to the prominence given to the effect of learning styles, their accompanying teaching styles and the influence learning styles have on learner performance.
- Other factors such as cultural and environmental factors, for example teacher qualifications, nutrition, emotional well-being, self-awareness and motivation, among others, may be worth investigating as factors, in addition to learning styles, to enhance performance in Mathematics.

5.8 CONCLUSION

In an attempt to determine the relationship between preferred visual, auditory and kinaesthetic learning styles and performance in Mathematics, the researcher became acutely aware that academic performance is much more complex than only alluding to isolating factors, such as learning styles, to improve performance. Moreover, the oversimplification of learning styles may hover on the one hand but perhaps the complexity of Mathematics itself was underestimated in the understanding of the encoding process of information.

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APPENDIX A: PERMISSION FROM THE POSTGRADUATE STUDIES COMMITTEE (UNAM)

UNIVERSITY OF NAMIBIA

Private Bag 13301, 340 Mandume Ndemufayo Avenue, Pionierspark, Windhoek, Namibia

Date: 28 October 2014

TO WHOM IT MAY CONCERN

RE: RESEARCH PERMISSION LETTER

1. This letter serves to inform that student: Carike Mans (Student number: 201202310) is a registered student in the Department of Educational Psychology and Inclusive Education at the University of Namibia. Her research proposal was reviewed and successfully met the University of Namibia requirements.
2. The purpose of this letter is to kindly notify you that the student has been granted permission to carry out postgraduate studies research. The School of Post- graduate Studies has approved the research to be carried out by the student for purposes of fulfilling the requirements of the degree being pursued.
3. The proposal adheres to ethical principles.

Thank you so much in advance and many regards.

Yours truly,

Name of Main Supervisor: Prof M.L. Mostert

Signed: ____________

Dr. C. N.S. Shaimemanya

Signed: ____________

Director: School of Postgraduate Studies
Tel: 2063523
E-mail: cshaimemanya@unam.na

APPENDIX B: PERMISSION FROM UNAM RESEARCH ETHICS COMMITTEE (UREC)

UNIVERSITY OF NAMIBIA

ETHICAL CLEARANCE CERTIFICATE

Ethical Clearance Reference Number: SEC/FOE/68/2014 **Date: 27 October, 2014**

This Ethical Clearance Certificate is issued by the University of Namibia Research Ethics Committee (UREC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the Faculty/Centre/Campus Research & Publications Committee sitting with the Postgraduate Studies Committee.

Title of Project: DETERMINING THE RELATIONSHIP BETWEEN PREFERRED LEARNING STYLES AND MATHEMATICS PERFORMANCE OF GRADE 5 LEARNERS IN WINDHOEK, NAMIBIA.

Nature/Level of Project: MASTERS

Principal Researcher: CARIKE MANS (Student No: 201202310)

Host Department & Faculty: Department Educational Psychology, Education

Supervisors : Professor M.L. Mostert (Main) (Co) Dr K.R.H. Veii

Take note of the following:

(a) Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the UREC. An application to make amendments may be necessary.
(b) Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the UREC.
(c) The Principal Researcher must report issues of ethical compliance to the UREC (through the Chairperson of the Faculty/Centre/Campus Research & Publications Committee) at the end of the Project or as may be requested by UREC.
(d) The UREC retains the right to:
   (i). withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,
   (ii). request for an ethical compliance report at any point during the course of the research.

UREC wishes you the best in your research.

Prof. I. Mapaure
UNAM Research Coordinator
ON BEHALF OF UREC

APPENDIX C: PERMISSION FROM PERMANENT SECRETARY OF THE MINISTRY OF EDUCATION TO CONDUCT RESEARCH

REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION

Enquiries:	Mr C. Muchila	Private Bag 13186,
E-mail:	Cavin.Muchila@moe.gov.na	WINDHOEK
Tel:	+264 61 2933200	Namibia
Fax:	+264 61 2933922	

File no: 11/1/1

Date: 18 February 2015

To: Ms CB Mans
P.O Box 97207
Windhoek
Cell: 081263 1789
carikemans@gmail.com

Dear: Ms Mans

SUBJECT: PERMISSION TO CONDUCT A RESEARCH STUDY IN KHOMAS REGION

Your correspondence regarding the subject above, seeking permission to conduct a research study in the schools of Khomas region has reference.

Kindly be informed that the Ministry does not have any objection to your request to conduct a research study at the identified schools.

You are, however, kindly advised to contact the Regional Council Office, Directorate of Education, for authorisation to go into the schools and for proper information coordination.

Also take note that the research activities should not interfere with the normal school programmes. Participation by either teachers or learners should be on a voluntary basis. Should you involve minors in your research activities, consent for participation should first be obtained from the parents/guardians of the minor(s).

By copy of this letter the Regional Education Director are made aware of your request.

Sincerely yours

18 FEB 2015

Mr. Alfred Ilukena
PERMANENT SECRETARY
cc: Directors of Education: Khomas

All official correspondence must be addressed to the Permanent Secretary

APPENDIX D: PERMISSION FROM KHOMAS REGIONAL COUNCIL TO CONDUCT RESEARCH

REPUBLIC OF NAMIBIA

KHOMAS REGIONAL COUNCIL

DIRECTORATE OF EDUCATION

Tel: [09 264 61] 293 4356
Fax: [09 264 61] 231 367/248 251
Enquiries: Ms T.L. Shivute

Private Bag 13236
WINDHOEK

File No: 12/3/10/1

26 February 2015

Ms CB Mans
P.O. Box 97207
Windhoek

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN KHOMAS SCHOOLS

Your letter dated 20 February 2015 on the above topic is hereby acknowledged.

Your request to do research in the following schools; Suiderhof Primary School, St Barnabas Primary School, Baumgartsbrunn Primary School, Mandume Primary School, Michele McLean Primary School, Gammams Primary School, Namibia Primary School and Pionierspark Primary School in Khomas Region to do your Master's thesis to establish "the relationship between preferred learning styles and Mathematics performance of Grade 5 learners in Windhoek" is approved with the following conditions:

- *The Principals of the selected schools to be visited must be contacted in advance and agreement should be reached between you and the principal.*
- *The school programme should not be interrupted.*
- *Learners/Teachers who will take part in this exercise will do so voluntarily.*
- *Consent from parents/guardians should be sought if minors are involved*
- *Khomas Education Directorate should be provided with a final copy your thesis.*

You are advised to approach the Principal and School Governing Body of Private Institutions; that is, Tanben College and Holy Cross Convent for appropriate approval.

I wish you success in your research.

Yours sincerely

MINISTRY OF EDUCATION
PRIVATE BAG 13236, WINDHOEK
26 FEB 2015
DIRECTOR OF EDUCATION
KHOMAS REGION

Gerard N. Vries
Director of Education

APPENDIX E: PRINCIPAL CONSENT FORM

UNIVERSITY OF NAMIBIA
SCHOOL OF POSTGRADUATE STUDIES

LETTER OF CONSENT

THE RELATIONSHIP BETWEEN PREFERRED LEARNING STYLES AND PERFORMANCE IN MATHEMATICS OF GRADE 5 LEARNERS IN WINDHOEK, NAMIBIA

DATA COLLECTION FOR RESEARCH THESIS SUBMITTER IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF M.ED PSYCH (GUIDANCE AND COUNSELLING)

I, ____________________ (principal) hereby grant permission for Grade 6 learners of this school to participate in data collection procedures for the research study mentioned above, of which the principal investigator is Ms CB Mans. The data collection procedures involves Grade 6 learners to complete a learning style questionnaire and a sensory wiring exercise with instruction and guidance from the researcher.

I have received, read and kept a copy of the information letter. Ms Mans has discussed the research study with me. I have had the opportunity to ask questions about the proposed research and I have received satisfactory answers. Therefore, I consent to the participation of Grade 6 learners of this school in the research study as the following were explained to me:

- the research may not be of direct benefit to me, the principal, the participating learners or the school
- all participation is voluntary
- parents should return the consent form before learners may take part
- learners should give assent
- the participants have the right to withdraw from the study at any time without any prejudice
- the risks includes possible inconvenience to the teachers, possible discomfort or harm (emotional or physical) as a consequence of the learners participating in the study
- all steps to be taken to minimise any possible risks

- what is expected from the Grade 6 learners and what is required to do
- whom I, the principal, should contact for any complaints about the research or the conduct of the researcher
- the school is able to request a copy of the research findings and reports after publication
- confidentiality and anonymity of the school and learners' personal information

PARTICIPATING SCHOOL : ______________________

NAME OF PRINCIPAL : ______________________

SIGNATURE : ______________________

DATE : ______________________

NAME OF WITNESS : ______________________

SIGNATURE : ______________________

DATE : ______________________

NAME OF RESEARCHER : ______________________

SIGNATURE : ______________________

DATE : ______________________

APPENDIX F: PARENT CONSENT FORM

UNIVERSITY OF NAMIBIA

SCHOOL OF POSTGRADUATE STUDIES

CONSENT FORM

2 March -17 April 2015

Dear Parent or Guardian

This letter kindly asks your permission for your child to complete a preferred Learning Style questionnaire and exercise that is administered to Grade 6 learners in selected schools as part of a research study. The purpose of this research is to gain insight to the relationship between visual, auditory and kinaesthetic learning styles and performance in Mathematics. It is in hope that the data collected will contribute to a better understanding of performance in Mathematics in the Namibian context and contribute to baseline data for future studies.

Your consent and your child's participation are completely voluntary and your child may withdraw at any point in time. There is no reward for participating or consequence for not participating. Your child's particulars and responses are confidential and anonymous. The school and your child's particulars will not be published in any publication of data collected or thesis.

The research study has been approved by the University of Namibia Ethics Committee (UREC), the Permanent Secretary of the Ministry of Education, Arts and Culture as well as the Director of the Khomas Regional Office.

If you agree to allow your child to participate, please sign below. After signing your name, kindly return this letter with your child to school tomorrow. Thank you in advance for your support and cooperation.

Parent's Signature : ________________________________

Child's name : ________________________________

(*Please Print*)

Date : ________________________________

APPENDIX G: LEARNER ASSENT FORM

UNIVERSITY OF NAMIBIA
SCHOOL OF POSTGRADUATE STUDIES

ASSENT FORM

THE RELATIONSHIP BETWEEN PREFERRED LEARNING STYLES AND PERFORMANCE IN MATHEMATICS OF GRADE 5 LEARNERS IN WINDHOEK, NAMIBIA

Dear Grade 6 learner

1. My name is Carike Mans and I am a M.Ed. Psych (Guidance and Counselling) student at the University of Namibia.

2. My lecturers, Prof. M.L. Mostert and Dr K. R-H Veii, and I am asking you take part in a research study because we are trying to learn more about the connections between learning styles and mathematics

3. If you take part in this study, I will ask you to do two things:
   * I will ask you to complete an sensory wiring exercise; and
   * I will ask you to complete a learning style questionnaire
   This will take approximately 20 minutes.

4. I do not believe that you will be hurt or upset by being part of this study. If you take part and believe you have been hurt or upset in any way, you may stop your participation. I will not tell anyone your personal details such as your name, surname or which school you go to.

5. This study will probably not help you directly, but the results will teach me important ways that can help teachers and the Ministry of Education, Arts and Culture.

6. You do not have to participate if you do not want to, regardless if the principal and your parents or guardians gave permission that you can.

7. Remember, being in this study is up to you and no one will be upset if you do not want to participate or even if you change your mind later and want to stop.

8. You can ask any questions that you have about the study. If you have a question later that you didn't think of now, you can ask your principal to contact me. He/she has my contact details.

9. Signing your name at the bottom means that you agree to take part in this study.

____________________________ ____________________

Signature of Grade 6 learner Date

APPENDIX H: LEARNING STYLE QUESTIONNAIRE

NAME & SURNAME : ____________________

STUDY ID NUMBER : ____________________

GENDER : **Male / Female**

DATE : ______ / ______ / 2015

LEARNING STYLE QUESTIONNAIRE

INSTRUCTIONS

A. The questionnaire is **completed voluntarily** and you, the participant, may **withdraw at any time**.

B. CIRCLE THE LETTER that **best describes you** in each situation.

C. You may choose **ONE OPTION ONLY**

1. **If I have to learn who TO DO SOMETHING, I learn best when I:**

   A. *watch* someone who *shows* me what to do

   B. *listen* to someone who *tells* me what to do

   C. try to *do it on my own*

2. **When I READ, I often find that I:**

   A. *fidget* and try to *feel* the object

   B. *imagine* in my mind *what I am reading* / I *visualize* the content

   C. *read out loud* of *hear* the words inside my head as I read

3. **When I am asked to give directions, I:**

A. give directions *verbally* (talking only)

B. give directions while *moving/pointing*

C. *see the actual place in my mind* while I am giving directions / *draw* it

4. **If I am unsure how to SPELL A WORD, I:**

A. see the word in my mind to determine if the word *looks* correct

B. spell the word out loud to determine if the word *sounds* correct

C. write the word to determine if the word *feels* correct

5. **When I WRITE, I:**

A. often *say* the letters and words to *myself*

B. am *concerned* about the *neatness* and *spaces* between my letters/words

C. *push hard* on my pen/pencil and *feel* the flow of the words/letters as I form them

6. **If I have to REMEMBER A LIST OF ITMENS, I remember best when I:**

A. *move around* and use my fingers to name each item on the list

B. *read* the list of items to myself

C. *say* the list of items *over* and *over* to myself

7. **I prefer a TEACHER who:**

A. explains by *demonstrating practical activities* in class

B. *talks* with a lot of *expression* in class

C. uses the *blackboard/chalkboard* or the *projector/data projector* in class

8. **If someone DESCRIBES SOMETHING verbally TO ME, I:**

A. become bored if his/her description gets *too long* and *detailed*

B. enjoy listening to the person, but *would rather interrupt* and *talk myself*

C. try to *visualize/imagine* what the person is saying

9. **When I have to SOLVE A PROBLEM, I have to:**

A. *say the problem out loud* to myself

B. *use my* entire *body* or *move* objects to help me think

C. *write* or *draw* pictures to help me think

10. **When I receive written permission on HOW TO BUILD SOMETHING, I:**

A. *first try to put the parts together* and then only read the instructions

B. *read* the instructions *silently to myself* and *imagine* how the parts will fit together

C. *read* the instructions *out loud* as I put the parts together

11. **To KEEP BUSY while WAITING, I:**

A. *look* around, *stare* or *read* a book, magazine or posters on the wall

B. *listen* to music to the radio in the background/ people talking

C. *walk* around, *play* with things in my hand, *move* or shake my feet as I sit

12. **If I have to verbally DESCRIBE SOMETHING to another person, I:**

A. *go into great detail* because I like to talk

B. *see* what I am describing in my mind and keep my story short

C. have to *move around while I am talking*

13. **I find it difficult to CONCENTRATE when:**

A. there is a lot of *clutter* in the room

B. there is a lot of *noise* in the room

C. I have to *sit still* for any length of time

14. **When I try to RECALL NAMES, I usually remember:**

A. the names, but forget the faces

B. when/where I met the person

C. the faces, but forgot the names

THANK YOU VERY MUCH FOR PARTICIPATING IN THE RESEARCH STUDY AND COMPLETING THIS QUESTIONNAIRE

The language of this questionnaire has been adjusted for the purpose of learner understanding. The questionnaire is based on the Self-understanding adopted from a learning style inventory used in an UNAM professional development workshop in collaboration with International Training & Education Centre in Health.

APPENDIX I: LEARNING STYLE QUESTIONNAIRE SCORE SHEET AND SUMMARY SHEET

	A	B	C
1	V	A	K
2	K	V	A
3	A	K	V
4	V	A	K
5	A	V	K
6	K	V	A
7	K	A	V
8	K	A	V
9	A	K	V
10	K	V	A
11	V	A	K
12	A	V	K
13	V	A	K
14	A	K	V

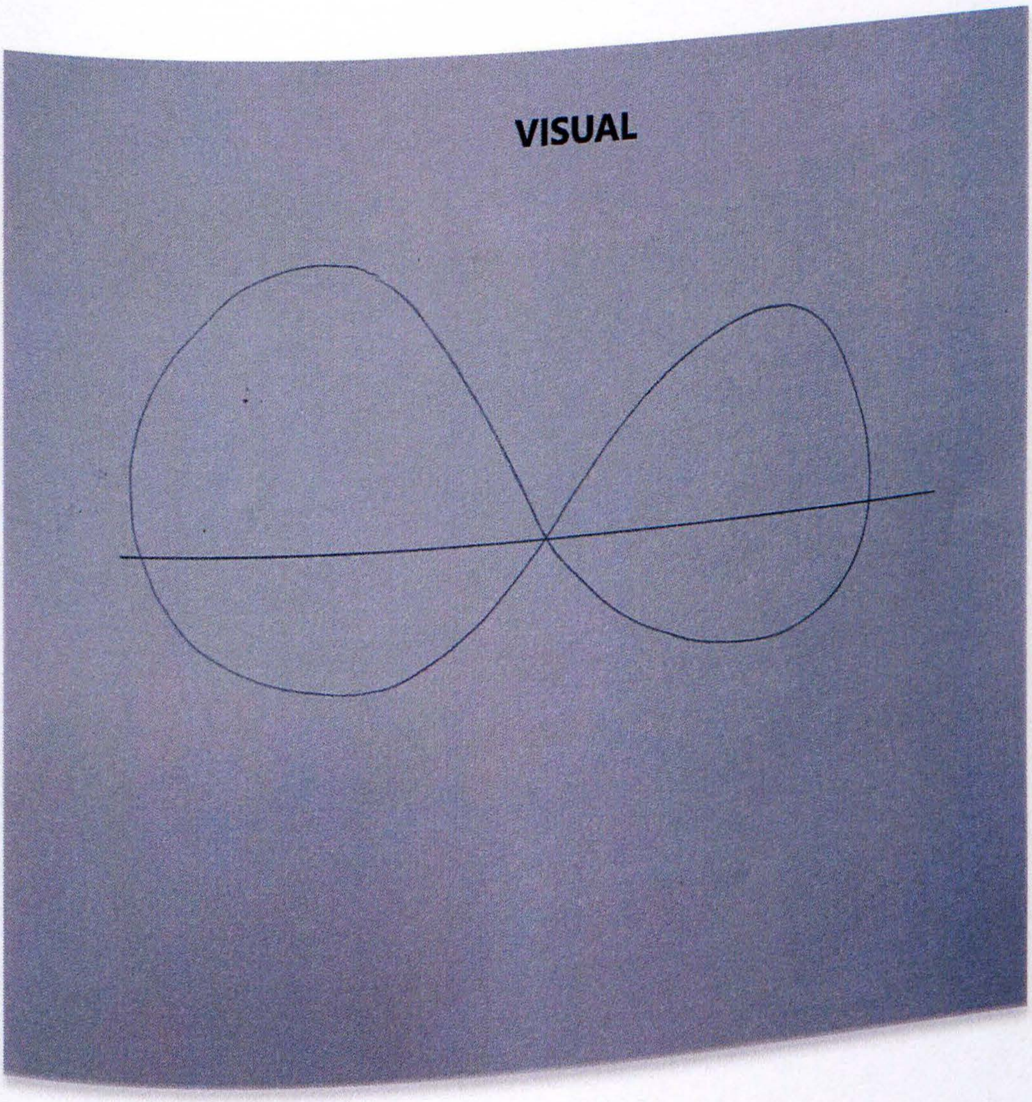
DATA COLLECTION SUMMARY		
1	NAME AND SURNAME	
2	STUDY ID NUMBER	
3	GENDER	male / female

4	RESEARCH INSTRUMENT	A	Questionnaire	V	/14
				A	/14
				K	/14

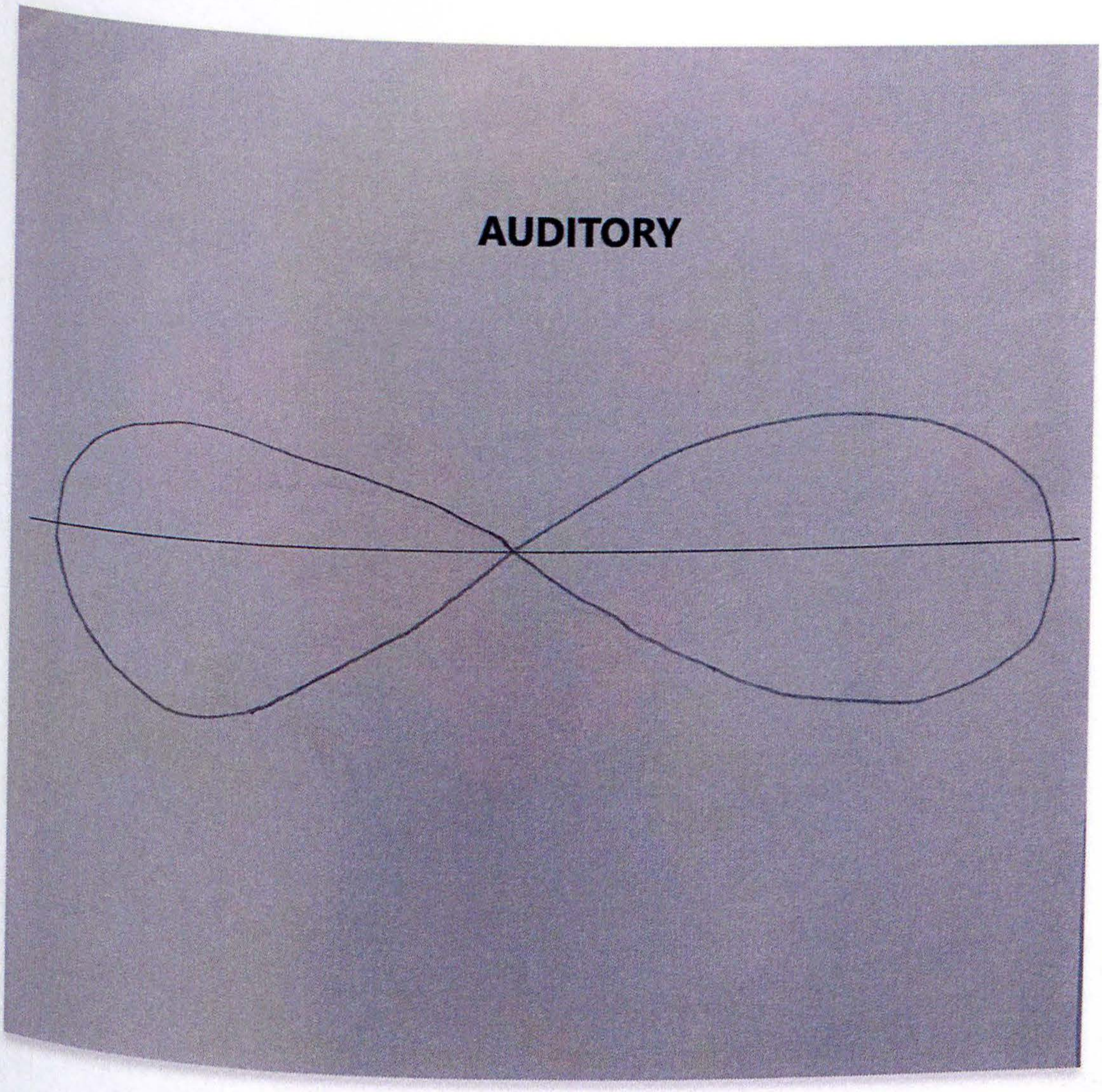
5	RESEARCH INSTRUMENT	B	Sensory wiring exercise	

6	RESEARCH INSTRUMENT	C	Math SAT score	%

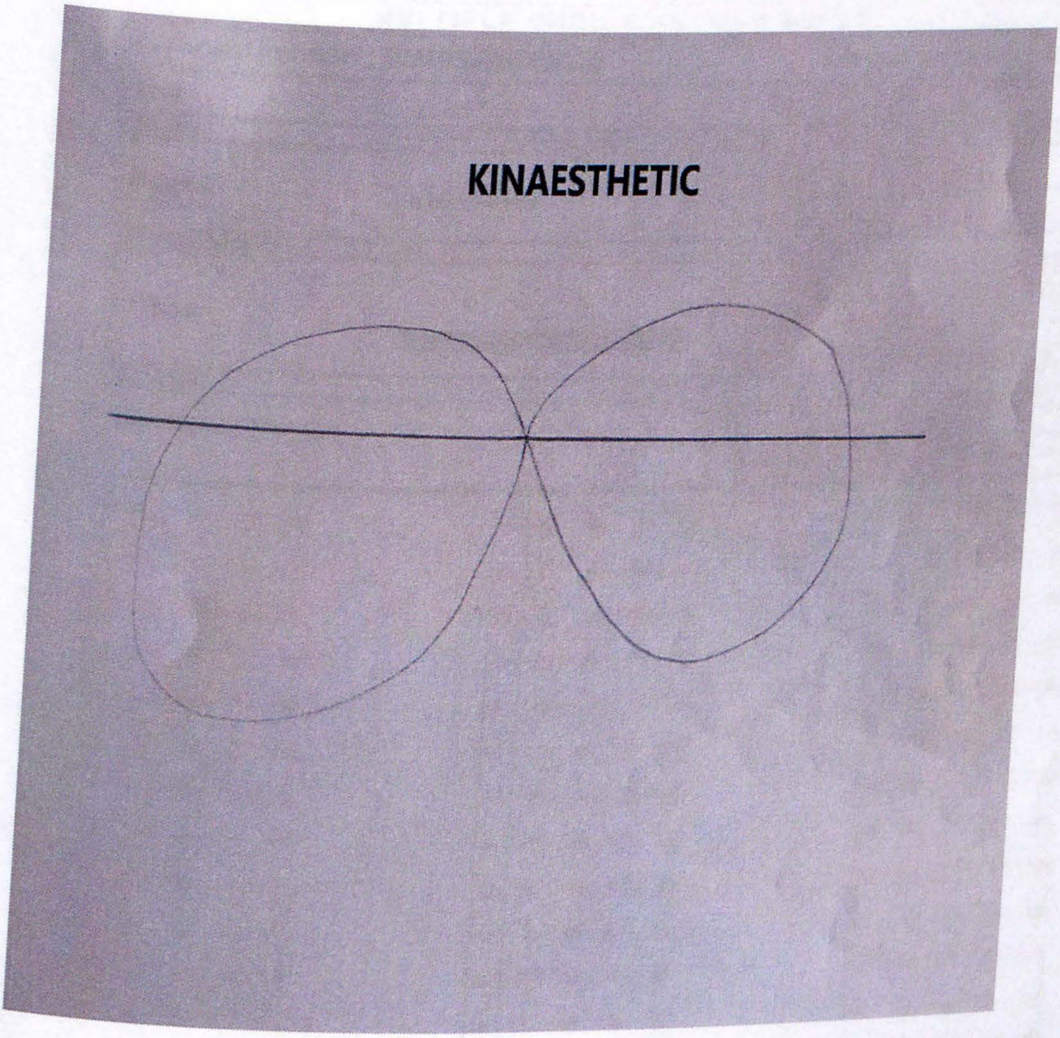
APPENDIX J: EXAMPLE OF A VISUAL PREFERRED LEARNING STYLE (SENSORY WIRING EXERCISE)



APPENDIX K: EXAMPLE OF AN AUDITORY PREFERRED LEARNING STYLE (SENSORY WIRING EXERCISE)



APPENDIX L: EXAMPLE OF A KINAESTHETIC PREFERRED LEARNING STYLE (SENSORY WIRING EXERCISE)



APPENDIX M: SAT SCORE SHEET

Republic of Namibia

Ministry of Education

15-SEP-14

National Standardised Achievement Assessment (NSAA)

C

MULTIPLE CHOICE ANSWER SHEET		
Name of Candidate	[redacted]	**Instructions on the back**
Year	201411	
Grade	GRADE 5 - FULL TIME	
Subject	MATHEMATICS	
Form Number	C	
School	[redacted]	
Gender		
Description Number		