Exploring mathematics teachers' challenges in using number pattern concepts from primary school at secondary school level in Amajuba district schools.

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DECLARATION

I Lionel Obrian Vukile Buthelezi, declare that:

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[redacted] 25 September 2023

Signature: Candidate **Date**

As the supervisor of the candidate, I agree to the submission of this thesis/dissertation

[redacted]

Signature: Supervisor

DEDICATION

This thesis is dedicated to God Almighty who was my guide, strength, pillar, and comforter through it all. Without God, I cannot do anything. The Holy Spirit kept on encouraging me when I felt like quitting. Through His guidance, I made it up to the final stages. It is also dedicated to my family for support, and the Shoba family for the guidance they gave me during the entire period of research. I also thank Mr Faya for being with me in case I have technological issues. Words cannot explain my sincere gratitude for their support from the beginning to the end of my research.

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- A big thanks to teachers who participated in the completion of questionnaires and/or undergoing interviews without a single complaint.

ABSTRACT

This research study focused on exploring mathematics teachers' challenges in using primary Number Pattern concepts when transitioning to the secondary school level. The study was carried out in three primary and four secondary schools in the Amajuba district of KZN in South Africa. This study intends to fill the gap created when learners transition from the GET to the FET phase. Matric examination and moderators' reports indicate that mathematics is the subject with the lowest performance in the country and Number Patterns are one of the poorly performed topics. This issue has been a challenge to mathematics teachers in South Africa, particularly in matric and grade 9 classes. The gap created when learners transition from the lower to higher grades in mathematics classrooms has been viewed as critical to challenges teachers encounter when teaching mathematics in higher-level classes. However, teachers in secondary schools discover in their teaching that learners do not have the required knowledge of Number Patterns that should be acquired in lower classes. Moreover, teachers begin to pinpoint or accuse those teaching in the lower classes of not doing their work properly. Therefore, this study aimed to answer the questions of *what* challenges mathematics teachers have when teaching Number Patterns, *how* they use their knowledge to overcome this problem, and lastly, *how* they overcome these challenges as the learners' transition from the primary school level to the secondary school level. Constructivism theory was used because it deals with what is happening inside the classroom. Qualitative data analysis methods were used to analyse data generated through questionnaires, individual semi-structured interviews, observations, and document analysis. A total of 3 primary school teachers completed the questionnaires and one of them underwent the interview and lesson observation. Four secondary school teachers participated in completing the questionnaire whereby three further participated in interviews and lesson observations. It was significant to conduct this study to help teachers improve their teachings by overcoming the challenges in Number Patterns, hence mathematics results will improve. The study discovered that if learners can do better in Number Patterns, they can improve in mathematics performance.

ACRONYMS

ABET	Adult Basic Education and Training
ACE	Advanced Certificate in Education
AMESA	Association of Mathematics Teachers in South Africa
ANA	Annual National Assessment
APS	Assessment Policy Statement
ATP	Annual Teaching Plan
BEd	Bachelor of Education
BSc	Bachelor of Science
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
DH	Departmental Head
DOE	Department of Basic Education
EACH	English Across the Curriculum
FET	Further Education and Training
GET	General Education and Training
IBE	Independent Examination Board
KZN	KwaZulu -Natal Province
NCTM	National Council of Teachers of Mathematics
NSC	National Senior Certificate
OBE	Outcomes-Based Education
PGCE	Post Graduate Certificate in Education
PTD	Primary Teachers Diploma
SP	Senior Phase
STD	Secondary Teachers Diploma
TCK	Teacher's Content Knowledge
TIMSS	Trends in International Mathematics and Science Study

LIST OF FIGURES

LIST OF TABLES

CODING USED IN THE STUDY

CODE	PSEUDONYM	DESCRIPTION
PSA	Ntuthuko Primary	1st Primary school in Amajuba District
PSB	Queen Primary	2nd Primary school in Amajuba District
PSC	Sakheleni Primary	3rd Primary School in Amajuba District
SSA	KwaMdakane Sec	1st Secondary school in Amajuba District
SSB	Phumzile Sec	2nd Secondary school in Amajuba District
SSC	Faya Sec	3rd Secondary school in Amajuba District
SSD	Sthembiso Sec	4th Secondary school in Amajuba District
PSA1	Vuyiswa	A teacher from the 1st primary
PSB2	Zakes	A teacher from the 2nd primary
PSC3	Thobs	A teacher from the 3rd primary
SSA 1	Phungula	A teacher from the 1st secondary
SSB2	Phindile	A teacher from the 2nd secondary
SSC3	Mlilo	A teacher from the 3rd secondary
SSD4	Bhagwana	A teacher from the 4th secondary

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter discusses the rationale, background of the study, motivation of the study, the focus of the study, problem statement, research questions, aims of the study, objectives, definition of the key terms used in the study, and chapter layout.

There is a serious concern about underperformance of mathematics from all stakeholders (teachers, department officials, learners and parents) in South Africa and the whole nation. Underperformance in mathematics has been a great concern in KZN, South Africa, Nationally and Internationally. The country is very worried about the subject underperformance as we are losing expertise especially in the field of Science. This underperformance is viewed in this study to be the cause of challenges in all mathematics topics including Number Patterns. Mathematics performance is effectively measured at the Further Education and Training (FET) exit level (grade 12). Teachers seems to have challenges when teaching mathematics topics including Number Patterns. At first look grade 12 teachers can be blamed for the poor performance however further research shows that this problem does not start only in grade 12 but in lower classes like grade 9. There are many learners who reached grade 12 without a single pass in mathematics in lower classes. I therefore decided to do this research to find out the challenges and make recommendations that can assist in overcoming the challenges.

1.2 Background of the study

The quality of teaching and learning of mathematics in South Africa has been a great concern to teachers, parents, department officials, and ordinary citizens (DBE, 2011). Reports refer to this concern of the poor achievement in mathematics by learners especially in grade 12, as a particularly huge problem that needs urgent attention (Kafata & Mbetwa, 2016). The mathematics results in grade 12 in the country show that performance in mathematics has never exceeded 60% nationally (DBE, 2021). Hence DBE declared 2023 as the year of mathematics and put a target of 60% and above for mathematics nationally. Learners are not performing well in Number Patterns and in other mathematics topics (Chand, Chaudhary, Prasad & Chand, 2021). Many researchers have also expressed great concerns about poor performance in mathematics, especially in Number Patterns (Michael, 2015). The Department of Basic

Education (DBE) went to the extent of declaring 2023 as the year of mathematics throughout the country. This is one of the actions by the DBE to express their deepest concern on the high failure rate in mathematics.

Number Patterns are perceived by many learners as one of the most complex parts of the curriculum and they often assume that it does not relate to their daily lives (Öztürk, Akkan & Kaplan, 2020). This contributes to the reasons learners struggle in Number Patterns and has posed a serious challenge to them and their teachers in most South African schools. Obara (2019), further stated that exposure to mathematical Number Pattern tasks is often very important for developing children's algebraic thinking skills and problem-solving strategies. There is a strong belief that students will not be able to overcome the difficulties of mathematics and will remain at the low level of mathematics difficulties that will distract them from mathematics courses and affect their attitudes towards mathematics lessons (Öztürk et al., 2020). According to Trends in Mathematics and Science Study (TIMSS) reports on learners' poor performance in mathematics, South African learners out of the 50 participating countries performed worst. Number Patterns were one of the weakest areas of performance.

Drago (2019) reported that high school learners' mathematical performance globally appears unimpressive. This shows that performance in mathematics is not only a problem in South Africa but is seen as a critical global issue in many countries (Ernest, Skovsmose, Van Bendegem, Bicudo, Miarka, Kvasz & Moeller, 2016). Many countries in the world especially in the African continent are not doing well in mathematics (Drago, 2019). Table 1.1 shows that for the past 5 years South Africa is not performing well in mathematics. Table 1.1 indicates clearly that mathematics is one of the worst underperformed subjects in the national examination (DBE, 2021c). Looking at the numbers written compared to the number passed, it can be concluded that almost half of the learners fail mathematics in a 5-year period as is also illustrated in Figure 1.1. This shows that much must be done in teaching and learning of mathematics.

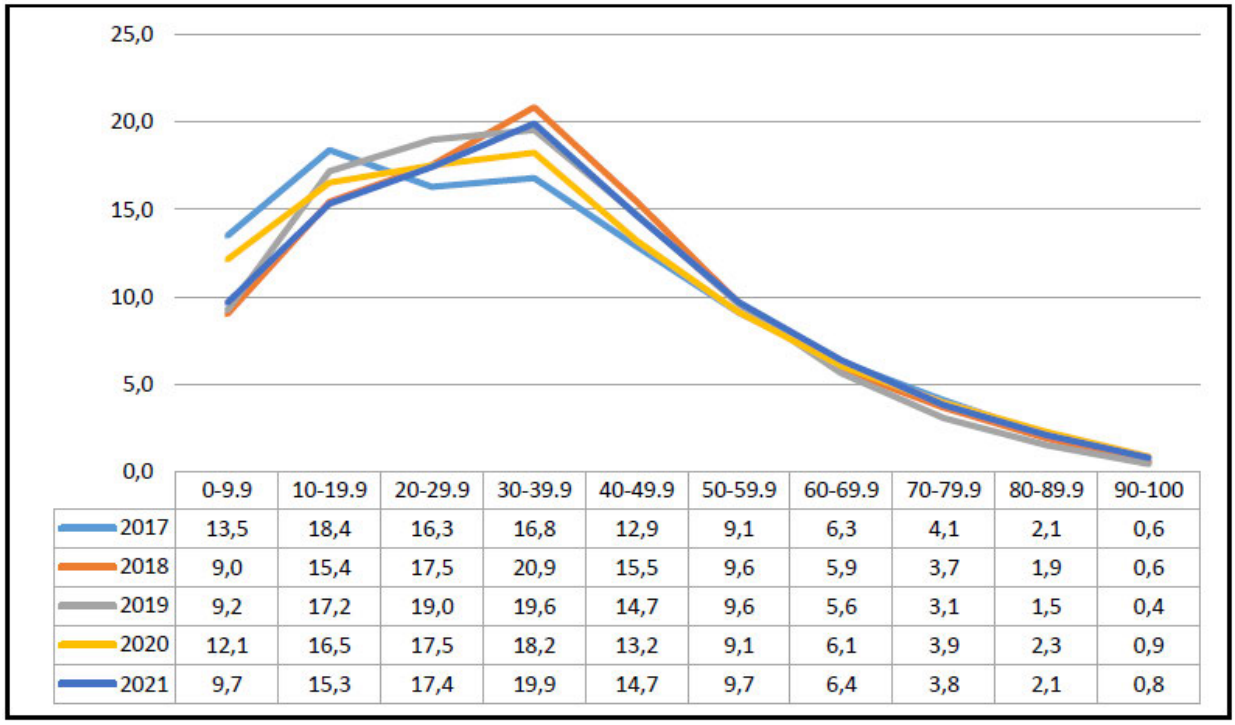
Table 1.1 Overall National achievement rates for South African Learners in Mathematics (DBE Diagnostic Report, 2021 p.184)

Year	No. wrote	No. Achieved 30% and above	% Achieved at 30% and above	No. Achieved 40% and above	% Achieved at 40% and above
2017	245 103	127 197	51.9	86 096	35.1
2018	233 858	135 638	58.0	86 874	37.1
2019	222 034	121 179	54.6	77 751	35.0
2020	233 315	125526	53.8	82 964	35.6
2021	259 143	149177	57.6	97 561	37.6

All stakeholders should pay urgent attention to mathematics teaching and learning trying to address these challenges. Number Patterns is always in Mathematics Paper One even during the National Curriculum Statement (NCS) in grades 10, 11, and 12 when other topics were relegated to an optional paper (DBE, 2006). There is no valid reason that can be brought forward to support the underperformance of Number Patterns. However, it is mandatory for all schools teaching mathematics in grades 10, 11, and 12 to teach Number Patterns to their learners in a proper way that will assist learners understand and perform to the required acceptable standard. The diagnostic grade 12 report on the 2019 national examinations of a sample of 100 scripts in each province found that the second lowest average in that sample for the mathematics paper one was in the question on Number Patterns (DBE, 2019).

One of the recommendations from the diagnostic report was that learners need to spend more time on problem-solving so that their mathematical skills can be improved. However, in my own teaching experience, I have noted that learners are undermining Number Patterns and prefer to spend most of their time revising the Algebra and Functions sections of mathematics. When trying to probe the reasons for the learners' poor performance in Number Patterns, some teachers reported that the mathematics teachers do not take enough time to teach learners this topic. As a subject specialist in my district I therefore see a need for teachers to devote more

time to Number Patterns as it poses challenges for the learners. It is therefore important for mathematics teachers to learn more about Number Pattern concepts with which current learners are struggling. Research in mathematics education will help identify ways to address some of these challenges faced by teachers in teaching Number Patterns. This study was carried out to identify challenges in the transition from primary level to secondary level that will help to improve mathematics performance, especially in Number Patterns.

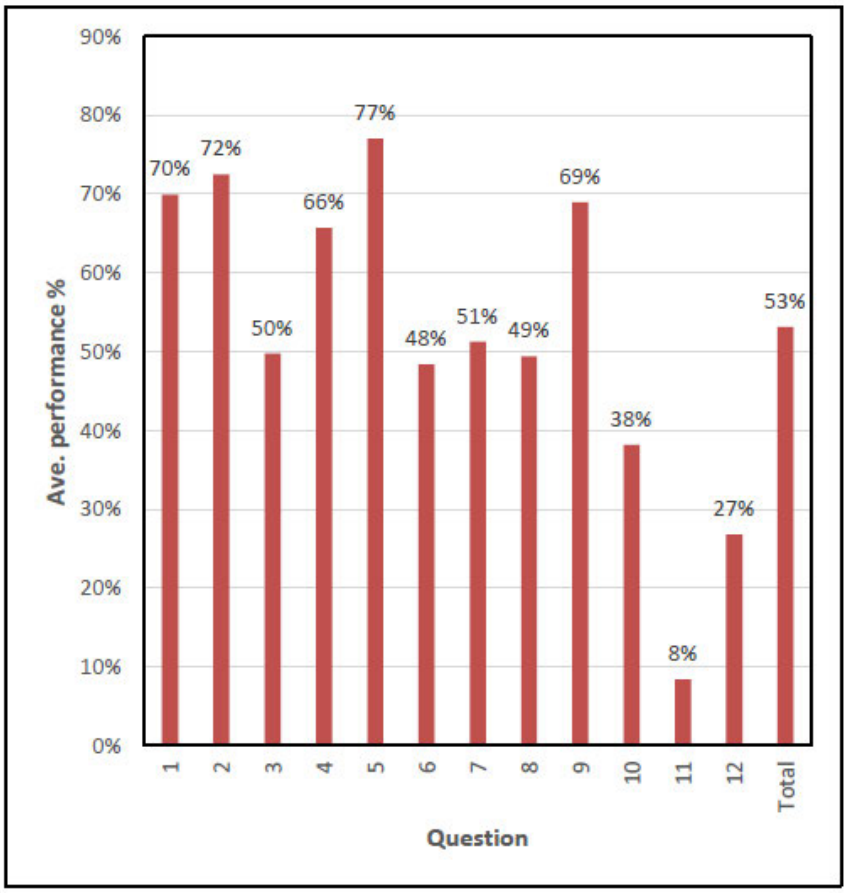


	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2017	13,5	18,4	16,3	16,8	12,9	9,1	6,3	4,1	2,1	0,6
2018	9,0	15,4	17,5	20,9	15,5	9,6	5,9	3,7	1,9	0,6
2019	9,2	17,2	19,0	19,6	14,7	9,6	5,6	3,1	1,5	0,4
2020	12,1	16,5	17,5	18,2	13,2	9,1	6,1	3,9	2,3	0,9
2021	9,7	15,3	17,4	19,9	14,7	9,7	6,4	3,8	2,1	0,8

Figure 1.1 National Performance per question distribution curves in Mathematics (DBE Diagnostic Report, 2021 p. 185)

The graph in Figure 1.1 further indicates that even those who pass mathematics are not obtaining quality results. More passes in mathematics are found in the bracket of between 30 and 40 which does not help those who want to pursue their careers in the subject at the tertiary level. In 2021 the average performance in mathematics was 57.6%. Looking at the learners' performance in the graph in Figure 2. It is noticeable that Number Patterns are one of the topics learners could not perform to the expected standard. Number Patterns contributes about 27 marks out of 150 in paper 1, which is 18% of the whole paper. If 18% can be taken out, only 72% will be left out

for the learners to pass Mathematics Paper One Learners have to make sure that they take all the 27 marks to be sure of 18%, which means they will only need 12 % to pass mathematics.



Q	Topics
1	Equations, Inequalities & Algebraic Manipulation
2	Number Patterns & Sequences
3	Number Patterns & Sequences
4	Number Patterns & Sequences
5	Functions & Graphs
6	Functions & Graphs
7	Functions & Graphs
8	Finance
9	Calculus
10	Calculus
11	Calculus
12	Probability & Counting

Figure 1.2 Average National Performance per question in Paper 1 in 2021 (DBE Diagnostic Report, 2021 p. 186)

In Figure 1.2, it is noticeable that Number Patterns is one of the topics learners performed at 50% and is the fourth lowest performed topic in six paper one topics. There is a 10% improvement observed from Number Patterns performance in 2021. If this pattern of improvement can be maintained we can see better performance in 2022 or 2023.

1.3 Rationale

Having noticed that teaching and learning of mathematics is a notable challenge to learners, teachers, schools, and the Department of Education, the researcher then decided to research this

challenge and see if the results can have an impact in changing the status quo of mathematics and Number Patterns in some schools. The performance in Number Patterns in the country has been a great concern to all stakeholders (DBE, 2011). The tables and graphs provided illustrated how learners are doing in all mathematics topics including Number Patterns. It is not only learners in grade 12 that are not doing well in mathematics, but other lower grades are also not performing to the expected standards. Wiberg (2019) compared grade 9 results with the international TIMSS countries which indicated poor results that are worse than grade 12.

Many schools are exhausting their resources on grade 12 programs, whereas the problem does not start in there but emanates in the lower classes. More resources and time are used in grade 12 classes. Programs to improve mathematics teaching and learning are done for grade 12 teachers. Interventions and special programs for underperforming schools in mathematics are priorities for all districts in the country. These schools are subject to writing common tests at the end of each term. The analysis reveals that teachers are under pressure in terms of curriculum coverage having to work within restricted timeframes, and having to meet the requirements of ATP, as a result they are leaving their learners behind (Du Plooy, 2015). This was confirmed when Annual National Assessment (ANA) examinations results were utilised in lower classes.

It was discovered through ANA that the overall performance of mathematics in grade 9 in 2014 was at the lowest level, which is 11% (See Table 1.2). Those results showed that learners were struggling with mathematics in grade 9. Teachers from lower grades found themselves under pressure to finish the syllabus as per ANA demand for testing and were concerned as people letting down the mathematics systems and progressions. Poor performance at the grade 12 level is caused by poor performance in lower grades especially in grade 9. The lower grades are the foundations of mathematics for the higher classes. If learners did not catch up well with Number Patterns in the lower grade, it is unlikely they will be able to perform well in the higher classes.

Using of problem-solving in place of just simply learning mathematics is the acceptable and correct way of teaching and learning of mathematics. Moreover, problem-solving exercises alone are not sufficient for teaching problem solving to learners, but teachers must also guide their learners accordingly (Kojo, Aura, Laine & Näveri, 2018). Number Patterns become easier

when problem-solving is adopted by the school as the tool to master solving mathematics problems. In the grade 9 CAPS document it is stated that problem solving, and cognitive development should be fundamental to all mathematics teaching. The National Council of Teachers of Mathematics (2000) stresses that problem solving must be the principal objective of the teaching and learning of mathematics in all schools giving every learner the opportunity to engage in different problem-solving activities (Chirinda & Barmby 2018).

However, most teachers perceive the teaching of mathematical problem solving as difficult (Akhter et al., 2015). Teaching of problem solving and their teaching strategies are effective when mathematics teachers support learners in the problem-solving process. Effective mathematics teaching and learning is done through problem-solving in many countries such as Japan, Australia, Finland, Singapore and many more (Malik, 2018). Problem-solving is valued and used effectively in all these countries. Felmer et al., (2016) emphasised that in Finland mathematical problem solving is approached as a unit rather than as separate areas of study. When teachers are teaching mathematics, they always infuse problem solving in all the lessons.

In Singapore, mathematics textbooks are primarily used to encourage problem solving (Cho et al., 2015). Primary textbooks have many word problems than other types. Real -world problems are frequently encouraged and used for teaching and learning in Singapore schools. Singapore textbooks have much more reasoning, characterised by pictures to make learning easier. America's problem-solving approach is a little different from Singapore and Finland. Rosenfield et al., (2018) mentioned in their study that Americans strongly believe in teams when dealing with problem solving and other mathematical issues. USA came second in Mathematics Girls Olympiad competitions 2023 and Australia came third.

According to Suseelan, Chew and Chin (2022) Australia regards problem-solving as the heart of teaching and learning of mathematics. Moreover, Chamberlin et al., (2022) emphasised that engaging students in solving non-routine word problems supports the sense-making of mathematics concepts learned. Suparman et al., (2021) mentioned that Indonesia adopted Problem Base Learning using problem-solving skills throughout their learning. There are two models of representation of problem solving in Indonesia namely writing the note, asking, and giving answers; and secondly is the solution to math problems taking the example,

demonstrating, and coming up with evidence. Takahashi (2021) clarified why teachers and students are doing so well in teaching and learning of mathematics in Japan. South African schools teaching mathematics need to adopt one of the teaching styles from one of the countries mentioned above to ameliorate challenges teachers have when their learners are transiting from lower classes to higher classes.

Teaching Through Problems (TTP) together with Collaborative Lesson Research (CLR) approaches are used in Japan and are very effective as Japan is rated amongst the top countries in mathematics. TTP encourages learners to try and solve problems independently without relying on the teacher. Problem solving can therefore be regarded as a powerful tool that can be used in any effective classroom to get good results. Teachers are therefore encouraged to use problem-solving skills in teaching all mathematics topics including Number Patterns. Mathematics develops problem-solving concepts as a fundamental component of school learning with a strong formative effect that represents the most effective of concepts to contextualisation that ensures sustainable and meaningful learning (Caprioara, 2015).

In a Number Pattern lesson, there should be a lot of problem-solving taking place for the best knowledge to the learners participating. Moreover, this shows that problem-solving goes hand in hand with Number Patterns and assists to make learning simpler and learners understand better. It is therefore important to engage all learners in all grades to this type of learning which has testimonies in countries that are doing well internationally in mathematics. Problem-solving is very important in the teaching and learning of mathematics. South African schools must learn from the countries that are doing well in mathematics to overcome the challenges they have. It is therefore important for the schools to adapt themselves to problem-solving to minimise the challenges they have when teaching Number Patterns in their respective schools.

1.4 Motivation for the Study

Researchers have expressed concerns about poor performance in mathematics (Michael, 2015). This is evident in Table 1.1 when learner performance from 2017 to 2021 was shown. Similar patterns have been observed when looking at the performances in 2021 and 2022. It was further shown in Figure 1 that Number Patterns greatly contribute to poor performance in mathematics. Number Patterns need a lot of attention by teachers in South African schools. Poor performance

at the FET exit level, grade 12 is a big concern for all the education fraternity and stakeholders. The problem is not only in grade 12 but starts from lower classes, especially in grade 9.

The introduction of the Annual National Assessment (ANA) in 2014 shocked everybody involved in mathematics that the status quo of mathematics in the country is the worst level. The overall mathematics performance during ANA testing for learners was very low in grade 9 and was of great concern. South Africa was identified as the worst performing country in mathematics in the world with Eastern Cape as the worst province (Alex & Juan, 2017). Based on this evidence, learners tend to have difficulties in mathematics sections and topics in lower grades and take these challenges as they move to the FET phase. It is of great concern to almost all South African citizens including teachers that the quality of teaching and learning of mathematics especially in grade 9 and primary schools is below the standard as compared to other countries and subjects. (Chirinda & Barmby 2018). This is because of insufficient use of problem-solving in the South African classrooms during teaching and learning.

This research investigated teachers' challenges in using Number Pattern concepts from the primary school level transitioning to the secondary level. Proposed in this research is to determine how teachers use their understanding of Number Pattern concepts to help learners use knowledge from the primary in secondary school content to close gaps. Furthermore, there is a need to research what factors affect teachers in effectively using Number Pattern concepts from primary to secondary school levels. In primary school teachers teach Number Patterns without using the formula hence they must have a way of introducing formulas at the secondary level. Senior Certificate examination moderators' reports indicate clearly that mathematics is the subject with the lowest performance in the whole of South Africa.

In the analysis done by mathematics moderators, it is observed that Number Patterns are a poorly performed topic. This is an easy topic for learners, they should not underperform in matric, but do better as they start this topic in lower classes. This shows that there might be some misconceptions or some lack of subject knowledge by teachers themselves. It is significant to conduct this study to help teachers improve their teachings and overcome the challenges encountered in transition from lower grades to higher grades Number Pattern teaching.

1.5 Focus of the study

The study primarily focuses on challenges that mathematics teachers have in using their knowledge of the Number Patterns learners acquired in primary transitioning to the secondary school level. According to the analysis done by DBE after every session of the matric final examination, it was observed that teachers are not doing well in teaching mathematics concepts including Number Patterns. This study intends to fill the gap created when learners transition from the GET to the FET phase.

Most of the damage occurred in grade 9 when the learners must choose between mathematics and mathematics Literacy. Hopefully, this study contributed to addressing the challenges teachers must have to bridge the gap created in Number Patterns while learners' transit to FET phases and beyond. Through the study it was discovered that there are serious challenges in mathematics teaching hence some recommendations were made on ways in which the situation could be improved. To address problems discovered during the research; the schools participated, and neighbouring schools were informed about the current problems and some possible solutions.

1.6 Problem Statement

The biggest problem with mathematics performance in South African schools is that mathematics performance in grade 12 has never exceeded 60%. Since 2010, the highest pass rate in mathematics is 59.1% according to DBE (2022). The department is trying to resolve the problem of mathematics in schools. A great deal of money has already been spent trying to fix this problem. (Chand, Chaudhary, Prasad & Chand, 2021). Most schools rely on lead teachers paid by the department to assist underperforming schools. Lead teachers are teachers taken from well-performing schools to assist in schools that are not performing well. Lead teachers use after-school hours to teach in those underperforming schools which are those schools that perform below expected standards. Using lead teachers is costly, however, using lead teachers will reduce expenses incurred by the department as they are trying to improve mathematics performance in the underperforming schools.

Schools' results depend on the performance of mathematics. The schools that are doing well in mathematics usually have good overall results. Mathematics was the worst-performed subject looking and comparing it with the provincial subject results in grade 12 between 2017 to 2021(see Table 1). Looking at 2022 results analysis it can be observed that all subjects performed more than 60% except mathematics (DBE, 2023). More attention is given to matric and most of the effort is given to matric ignoring the lower classes which causes a lot of damage. ANA emerged trying to deal with the gap occurring during the transition from primary to secondary but was discontinued due to political reasons. During the times of ANA focus was not only on matric but also on grade 9 and other lower classes. Dumigsi and Cabrella (2019) discovered that material used in grade 9 learners in solving problems involving quadratic functions that includes Number Patterns was very effective.

ANA results reflected that as from 2012 grade 9 results have not gone beyond 14% which means more than 86% of grade 9 learners failed mathematics. Clear learning gap between children from advantaged and non-advantaged backgrounds especially in grade 4 and 9 was observed when analysis of performance in all grades participating in ANA (Leder, 2015). It is evident that learners' performance in ANA results is declining as the learners' transit from lower to higher grades. Table 1 shows clearly that grade 1 results are far better than grade 9 results as there is a sharp drop from grade 6 to grade 9. This poor performance shown by learners made the Minister and the DBE to institute some drastic measures to deal with weak quality of teaching mathematics in grade 9 accordingly (Van der Berg, 2015). Unions intervened in 2015 and stopped the ANA administration which were postponed to 2016 but did not materialise. This research is going to help in exploring challenges faced by teachers in transition with their learners from lower classes to higher levels.

Table 1.2 Average mathematics scores in ANA, 2012 -2014 (Van der Berg, 2015 p.3)

	2012	**2013**	**2014**
Grade 1	68	60	68
Grade 2	57	59	62
Grade 3	41	53	56
Grade 4	37	37	37
Grade 5	30	33	37
Grade 6	27	39	43
Grade 9	13	14	11

1.7 Research Questions

1. What challenges do mathematics teachers have in using number pattern concepts from primary school at secondary school level?
2. How do teachers use their knowledge of number pattern concepts from primary school at secondary school level to overcome challenges?
3. How do these challenges affect teaching of number pattern concepts at secondary school level using their primary school knowledge?

1.8 Aim of the Study

Aim of the study is to identify challenges teachers have in teaching Number Patterns to learners from primary school at the secondary school level

1.9 Objectives

1. To identify challenges mathematics teachers have in using Number Pattern concepts from primary school at the secondary school level.

2. To determine how teachers use their understanding of Number Pattern concepts from primary school knowledge at secondary school teaching to overcome challenges.

3. To determine the extent to which challenges in using Number Pattern concepts from primary school at secondary school level, affect teaching

1.10 Definitions of key terms used in the Study.

Code-switching – this is the practice of alternating between two or more languages or varieties of language in teaching to help second language speakers understand in their mother tongue.

Constructivism - this is the theory that says learners construct knowledge rather than just passively take in information. In this study, learners need to apply the knowledge acquired in lower grades at higher levels which minimizes challenges teachers encounter when teaching Number Patterns.

Department of Basic Education (DBE) – this is the section of education that deals with all schools from grade R to grade 12, including adult literacy programmes.

Early Childhood Development (ECD) – can be a stand-alone and not found on the primary school premises.

Foundation phase (FP) – this is the entrance phase to education starting from grade 1 up to grade 3.

Further Education and Training (FET) – this is the phase starting from grade 10 and proceeding up to grade 12. This is the last phase of the DBE and exit of FET.

General Education and Training (GET) – this is the phase starting from grade 7 up to grade 9. In our South African system of education, this phase starts in primary school and proceeds to the secondary school level, unlike other provinces like Eastern Cape where grades 7, 8, and 9 are in the same premises called junior secondary.

Intermediate phase – this is the stage whereby the language of teaching changes from mother tongue to first additional, especially in black schools and starts from grade 4 up to grade 6.

Language switching – this happens when someone begins speaking or learning in a different language. In this study, we observed and discussed the syllabus demanding changes in the language of instruction from the mother tongue to English in grade 4.

Primary level – in South Africa especially KwaZulu- Natal, the primary level starts from grade R to grade 7. Although grade R is in the primary level, it may not be found in premises with other primary level classes.

Secondary level – in South Africa this is a level of education starting from grade 8 to grade 12 which is the exit point to the Tertiary level.

Senior phase – this phase is found in both primary and secondary schools. In primary schools, we find grade 7, and, in secondary schools, there is grade 8 and 9.

Tertiary level – education level starting after completing grade 12 where learners become students and pursues their careers.

Transition – this is the process whereby learners are changing classes or phases in their learning moving from lower (grade 7 to 9) to higher classes (grade 10,11 12).

Underperforming schools - are those schools that perform below expected standards.

1.11 Chapter Layout

This study consists of six chapters organised as follows:

- Chapter 1 – Introduction

This chapter provides the rationale, background, motivation, focus, the problem statement, research questions, aim, objectives, definitions of key terms, chapter layout and conclusion. In this chapter more, focus was on looking at the problem for mathematics and addressing challenges teachers have when teaching Number Patterns as their learners' transit from lower to higher grades. Tables and figures displayed showed the performances for different years.

- Chapter 2 – Review of the Literature

This chapter also highlights gaps in current research in the field and looks at the mathematics curriculum, mathematics teacher and teaching. Developing understanding of mathematics, Number Patterns and challenges observed during transition of learners from lower to higher grades were deeply researched.

- Chapter 3 – Theoretical Framework

Constructivism theoretical framework was thoroughly discussed in this chapter. Constructivism was then compared and fused with mathematics learning and mathematics teachers and again integrated with different parts of the study. Social constructivism was also discussed and infused with the learning of mathematics.

- Chapter 4 – Research Methodology and Procedures

This chapter has an introduction, the paradigm, design, philosophy and strategies for research. Furthermore, data collection instruments and procedures and data analysis procedures were also discussed. Trustworthiness, ethical consideration and limitation of the study were presented. Inductive and deductive approaches were discussed and presented in a model.

- Chapter 5 – Data Presentation, Discussion, Interpretation and Analysis

This chapter presents data collected, discussing interpreting and analysing it which was generated using questionnaires, interview and lesson observations. Participants' profiles were arranged in a table form and analysed accordingly.

- Chapter 6 –Discussion of Findings, Recommendations and Conclusion

This chapter discusses, concludes, and provides recommendations of the study. Findings in relation to research questions, relevant literature, and construction theory and methodology were also discussed in detail. The research was concluded in this chapter.

1.12 Summary

The background, rationale, motivation and focus of the study were discussed. Problem statement, research question, objectives, definition of terms, and layout of the study were presented. The next chapter discusses the review of the literature.

CHAPTER 2: REVIEW OF THE LITERATURE

2.1 Introduction

The following subtopics will be discussed in this chapter: Mathematics Curriculum in South Africa, Mathematics teacher, Mathematics teaching, Developing Understanding of mathematics, Number Patterns, Challenges during transitioning from lower to higher grades and conclusion. The aim of the study is to explore challenges teachers have when teaching Number Patterns to learners in primary transitioning to the secondary school level. All subtopics that are discussed in this chapter have to align with the aim and research question for the study.

This chapter specifically reviews related literature on mathematics especially Number Patterns. Focus is on teaching and learning of mathematics or Number Patterns, and looking at the best practices that can be adopted to improve standard of mathematics in the country. Literature is reviewed drawing from South Africa, SADC countries, and internationally. Literature review is an important ingredient in all researches. The existing literature concentrates on the challenges teachers have in teaching of mathematics rather than on Number Patterns. The researcher saw the need of researching the challenges teachers have in teaching Number Patterns as learners progress to higher classes. It was because of the crisis in mathematics underperformance that a literature review is needed for the study to minimise or stop the challenges teachers have when their learners are transiting from lower classes to higher levels. This section reviews relevant literature on Number Patterns and some mathematical issues.

2.2 Mathematics Curriculum in South Africa

Curriculum in South Africa is based and rooted on the National Curriculum Statement (NCS) and Assessment Policy Statement (APS). This is a single, comprehensive, and concise policy document that must be used by all teachers when teaching mathematics. This document is used to refer to when teaching mathematics and also used by other subjects as well. Learning and Assessment Guidelines for all the subjects are listed in details in the National Curriculum Statement Grades R to 12. Outcomes-based education (OBE) that was introduced in 1997 to overcome the curricular divisions of the past didn't help to change the status quo of mathematics in South Africa, instead it brought more confusion and contributed to the underperformance seen at different schools. The

failure of OBE caused these challenges teachers have in using Number Patterns concepts from primary school at secondary level.

The introduction Revised National Curriculum Statement (RNCS) Grades R-9 and the National Curriculum Statement (NCS) Grades 10-12 tried to address the gaps created by the OBE in Mathematics (Cabrera, 2017). RNCS and NCS were combined into a single document known as the National Curriculum Statement Grades R-12 which still in used at the moment. The National Curriculum Statement for Grades R-12 looks better than the all other statement policies tried in the education system in South Africa. The effective use of the NCS can help to overcome the challenges teachers have when teaching Number Patterns transiting from lower to higher levels. There have been many changes in the South African mathematics curriculum such that mathematics education has been shaped and changed many times in a short period of time (Jojo, 2019). Teachers in South Africa were at a certain stage confused as changes were imposed on them. Outcomes Based Education and Curriculum 2005 failed while teachers were trying to adjust, and we are still unsure whether the current one will sustain.

Changes that took place in the curriculum affected the curricula of all subjects including mathematics. Teachers and learners were equally affected by these curriculum changes which led to poor performance and understanding of the subject. Many challenges teachers encountered when their learners' transit from lower to higher grades emanated when those changes were implemented. Number Patterns in grade 9 mathematics curriculum looks tougher for the learners and challenging for some teachers. According to Spangenberg & Pithmajor (2020) many grade 9 mathematics learners in South Africa face difficulties in solving Number-Pattern problems. Learners need to be exposed to strategies of problem solving in order to overcome challenges teachers have in using Number Pattern concepts from Primary school at secondary school level. They further advised that learners need to utilise four main strategies in order to solve any mathematics problems including Number Patterns. Strategies like counting; direct proportion; recursive strategy; and mental image representation can help many learners to master mathematics concepts with ease (Spangenberg & Pithmajor, 2020).

Teachers need to have knowledge of these strategies that can assist their teaching and learning of number-pattern problems in their classrooms. As stated above most learners in South Africa

face challenges in solving all mathematics problems including Number Patterns. It is therefore necessary to check and identify the sources of these problems and do necessary recommendations. One source of this problem is that learners in most schools lack necessary resources (Spangenber & Pithmajor, 2020). Learners from many schools share textbooks, calculators, and other resources. Learners must have exposure to Number Pattern problems as prescribed in the CAPS document and their textbooks for the specific grade (Molutsoane, 2019). Teachers are trying their best to help learners understand all concepts of Number Patterns and remember everything they learnt from the previous classes.

2.3 The Mathematics Teacher

A mathematics teacher must be somebody qualified and have necessary skills to teach all mathematics topics. One of the research questions was how teachers use their understanding of Number Patterns concepts to overcome challenges in secondary school level. A qualified teacher doesn't have a problem with handling the content and delivering it properly to the learners they are teaching. Although newly appointed teachers from the tertiary institutions come with new and fresh ideas, experience is the requirements of the good mathematics teacher. The newly appointed teachers who are well trained in their tertiary training together with the experienced teachers are needed by the system of education. Schools with good quality mathematics composed of experience as well as newly qualified teachers use to produce good results. This shows that the schools' systems of appointing mathematics teachers must recruit and appoint qualified competent mathematics educators in the primary and secondary schools to overcome the challenges teachers have when teaching Number Patterns transiting from lower to higher levels.

Teachers teaching grades 11 and 12 mathematics need to be trained differently from other teachers (Adler, 2017). Experienced teachers have to be taken care of by continuously capacitating them especially in mathematics below and above grade 12 content. They must do advanced mathematics that is above grade 12 content in order to keep their level above their learners. Most of the chapters taught in grades 11 and 12 are challenging and need a knowledgeable teacher (Harvey & Goudvis, 2017). Some teachers cannot teach Number Pattern concepts at the different phases for different reasons (El Mouhayar, 2019). One of the reasons

is that they were not taught this concept properly when they were still at school, while others especially those in the primary schools were struggling to pass maths during their times while they were still learners. Some do not even have a mathematics qualification in their grade 12 certificates because they dismally failed the subject.

According to Arthur et al., (2018), learners are more interested in mathematics when mathematics teachers give them more time to interact with different mathematics problems in the classroom environment especially when they are working with peers in groups. They further acknowledged that integrating mathematics with other subjects helps them understand mathematics concepts easily. It is therefore very essential to connect mathematics to real life problems for mathematics interest development process. Teachers must be trained properly in all aspects and skills that will be required when they are teaching learners in their classrooms (Jojo, 2019). In South Africa, the minimum requirement for being a mathematics teacher is the three-year training which appears to be inadequate. (Alex, 2019). In some other countries, the entrance qualifications for mathematics appointment as a teacher in their schools are pitched to a master's degree and above (University Grants Commission, 2018). However, in South Africa, many teachers have a minimum of a 3-year diploma as the qualification to teach mathematics at any level, and very few have master's degrees and above (Buthelezi, 2018). The number of unqualified teachers has been reduced drastically.

The Department of Education took a strong measure in order to reduce the number of unqualified and under-qualified teachers in its teacher workforce (Burton, 2018). This was done through the provision of bursaries and scholarships to unqualified and under qualified teachers. Others were offered opportunity to do National Professional Diploma in Education (NPDE) on top of qualifications they have which were not qualifying them to be teachers. As a result of these move the number of unqualified and under-qualified educators has been reduced significantly since 1994 (Onwu & Sehoole, 2015). The proportion of teachers falling under these categories has been reduced drastically in such a way that there are no more unqualified teachers in the system of education. System used in education fraternity cannot accept or capture unqualified teacher. A new system of Professional Development (PD) points will soon be adopted and used in South Africa. Teachers will earn 150 PD points in a three-year cycle, undertaking a variety of professional development activities. This PD system is endorsed by the

South African Council for Educators (SACE) on the grounds of their fitness for purpose and quality. The PD method is an internationally recognised technique used by professional bodies in many fields.

The purpose is to acknowledge members' continuing professional development. Unions are still scrutinising this idea and it will only be adopted when unions agree with it. The problem of mathematics is not only troubling South African teachers, but other countries are having a similar problem. Mazana et al., (2020) researched mathematics performance in Tanzania and discovered: "The transition from primary school to lower secondary school shows more passes in primary school mathematics examinations, while in lower secondary education there are more failures cases. High failure rates at this level calls for a deliberate intervention at a four-year cycle of secondary education where learning of mathematics becomes more difficult for students. This will consequently affect the higher education enrolment and quality of students' computational skills in college mathematics. Close examination of the students' performance data revealed that the percentage rates of students failing mathematics are generally higher." Mathematics teachers need to unite globally to create the solution to overcome challenges they encountered when teaching Number Pattern concepts from primary school at the secondary school level.

There are multiples of factors that directly impact on learning of mathematics in the school environment. Teacher effectiveness is at the essence of learner success hence, the link between Teacher Content Knowledge (TCK) and learner achievement is very important (Odumosu & Fisayi, 2018). Mathematics teachers are trying their best to improve the teaching and learning of mathematics. Teachers are working unpaid overtimes trying to fix the problem of mathematics underperformance. South Africa is continuously producing good mathematics teachers who can teach the subject effectively and overcome the problem of poor performance and the high failure rate (Tachie, 2020).

2.4 Mathematics Teaching

Mathematics teaching is a very important process of transposing knowledge to the learner which needs to be done with extra care. It is a great concern that challenges affecting teaching of number pattern concepts at secondary school level using primary school knowledge are

addressed properly to overcome challenges teachers encounter in teaching of this topic. “Mathematics is a unique subject, which encourages the acquisition of specialized science skills and knowledge, which explains the natural phenomena of life in society” (Das, 2019). Many teachers use procedural teaching in their lessons as they only want to see their learners knowing the steps and algorithms of the problem and to just memorise formulae to answer the questions without deeper understanding. The terms procedural knowledge is often used by teachers when discussing how they teach, and how their learners learn mathematics. In lower classes formulas are not used and learners need to have deeper understanding of how to answer the problem without the use of the formula.

Teachers need to combine procedural and conceptual understanding for achieving best results and performance. Teachers must start with conceptual knowledge and then move to procedural knowledge for clear understanding (Hurrell, 2021). Different learners need to be taught differently as one size fits all does not work in the teaching of mathematics. For teaching to be effective learners must always feel comfortable and willing to learn. Teachers must always focus on creating a classroom environment that is conducive to learning where learners can share and communicate their ideas freely with their teachers and understand everything they are taught (Akram, 2019). Learners are creative beings and have ideas of their own. Mathematics teaching needs learners to work and teachers just guide and check their workings. Teaching and learning of mathematics needs to be framed in sound understanding of procedural and conceptual knowledge (Hurrell, 2021).

Many learners in South Africa cannot do their desired careers because they have poor results in mathematics. One of the topics that let them down is the Number Patterns. This study identified the gap created in Number Patterns when learners transition from the GET to the FET phase. It was observed that most of the damage occurred in grade 9 where they have to choose between Mathematics and Mathematical Literacy. Most learners make wrong choices at this stage. Weak learners in mathematics must choose mathematical literacy instead of pure mathematics. Mathematical literacy is a subject undermined by most learners and mathematics teachers but is useful in daily life. (Li, 2019). For learners to choose mathematical literacy in grade 10 will help mathematics teachers to have a group of learners that will cope with mathematics scope.

Teaching of mathematics in primary and secondary schools is not yearning the expected results (Mazana, Montero, & Olifage, 2019). Teachers need to change from teacher-centered to learner-centered teaching. South Africa must change the teaching of mathematics and align with what is done in countries that are doing well which features problem solving. Teaching Number Patterns or/and any other mathematics topic will be easier with the adoption of problem-solving and challenges will be reduced. This problem affects even those who manage to pass mathematics in grade 12 as they proceed to tertiary level. They find themselves not coping with the Higher Education Department (HED) mathematics which results in many dropouts. More than half of South Africa's tertiary students do not complete their education (Mlachila & Moeletsi, 2019). According to Murray (2022), most of the dropouts at the universities are mathematics students who struggle with mathematics, that is about 25 percent of students enrolled in tertiary education in South Africa drop out in their first year. To avoid this high dropout rate teachers in primary and secondary schools need to change the way they are teaching their learners mathematics.

The Department of Education had a task to address the crisis that arose after ANA results analysis. According to Shoba (2020) the Department of Basic Education responded by showing interest and willingness to adopt and use problem-solving for mathematics in South African schools. However, problem-solving seems to be the solution for the underperformance reflected in grade 9 ANA results analysis. Learners must understand everything that is taught to them by their teachers in every mathematics lesson including Number Patterns. Teachers must play a very significant role and provide necessary guidance to the learners in order to overcome challenges they have when teaching their learners Number Patterns moving from lower to higher classes. A learner-centered approach whereby a teacher becomes a facilitator and a coach, makes learners accept responsibility of learning (Darsih, 2018). Techniques to solve problems need to be thoroughly practised with learners in the mathematics classroom (Shoba, 2020).

2.5 Developing an Understanding of Mathematics

Mathematics must be taught in such a way that learners understand. The pressure from the department makes teachers teach learners to pass, by using past years' papers. According to Dahlan and Wibisono (2021) the basic ability that students must have in learning mathematics

is the ability to understand mathematics concepts. However, a research report conducted by TIMSS in 2011 shows that Indonesian students had low ability in understanding the concepts and mathematical reasoning (Siregar et al., 2021). It is further observed that it is not only South African learners that do not understand mathematical concepts, but also other countries. Mathematical learning in many schools is often teacher-centered instead of learner-centered. Learner-centered learning makes learners easily understand concepts as learners are learning easily from each other than from the teacher. Learners need to be encouraged and motivated to work independently and explore things for themselves without fear. Motivation alone cannot help the teaching of mathematics effectively but understanding mathematics concepts including Number Patterns must be considered in every mathematics teaching.

Teachers need to teach Number Patterns to learners such that they thoroughly understand the concept. Most teachers are wrongly using past examination papers in their teaching as they only teach learners to pass mathematics without proper understanding. Learners taught in that way will pass mathematics but cannot cope with tertiary mathematics which leads to dropouts in the Higher Education Department (HED). Knowledge from lower classes play an essential role when learners transit from lower to higher classes. It is very difficult for the learners to do well in Number Patterns if they do not have proper prior knowledge of all Number Patterns concepts. Rittle-Johnson and Siegle (2022) mentioned that the core for mathematical understanding is the relationship between learners' understanding of mathematical concepts and their ability to execute procedures. With these two types of knowledge understanding of concepts gradually develops. Development occurs when concepts and procedure of what children learnt during development builds up in the mind of the learner (Rittle-Johnson & Siegler, 2022).

2.6 Number Patterns

Number Patterns is not a very difficult topic that learners should fail. Knowledge of Number Patterns concepts from primary school level is the prerequisite for learners doing Mathematics in the secondary school level. Learners in the secondary school level seem to perform very poorly in this topic (DBE, 2021). Number Pattern are problematic to most learners because of insufficient exposure to problem-solving strategies as many schools have not adapted problem solving

strategies in their teaching and learning (Ying et al., 2020). It is recommended that for learners to do well in Number Patterns teachers have to utilise problem solving strategies in their teaching (Lamon, 2020). Knowledge of different strategies could assist teachers in their teaching of Number Pattern problems as their learners' transit from lower to higher grades in their classrooms. However, South African learners continue to perform poorly in mathematics throughout all grades as compared to their counterparts internationally, locally and regionally (Van Staden & Motsamai, 2017). Specifically, most learners in South Africa have difficulties in solving Number Pattern problems (Spangenberg & Pithmajor, 2020). The greatest difficulty learners encounter in Number Patterns is to translate real-life issues into mathematical problems (Spangenberg & Pithmajor, 2020).

Solving Number Patterns problems is not necessary a problem to learners when they are actively involved in problem-solving. Learners find it challenging to work out Number Patterns problems of any nature as they transit from lower to higher classes (Chinn, 2020). Teachers need to simplify Number Patterns so that learners understand, and challenges are then minimised. It is significant to address the challenges teachers have in teaching Number Patterns topics using the basic knowledge learners acquired in lower classes. The study primarily focuses on the challenges that teachers have in using their knowledge of the Number Patterns learners acquired in primary transitioning to the secondary school level. However, according to the analysis done by the DBE after every session of the matric final examination, it was observed that grade 12 teachers are undermining the Number Patterns topic ending up not giving full attention to it. If this problem can be addressed properly, problems encountered by teachers when teaching number patterns will be resolved and the mathematics pass rate will also improve drastically.

Many teachers teach Number Patterns through rote learning which adds to challenges teachers have when teaching them as learners' transit from lower to higher levels (Schaathun, 2022). Learners just memorise concepts without understanding. Teachers want learners to understand mathematics and to become efficient problem solvers whereas they do not teach them in a proper way that will eradicate problems and misconceptions. Many teachers are still teaching by rote learning producing learners that are rote thinkers (Lithner, 2015). This is one of the main reasons why learners still have difficulties in mathematics including Number Patterns. No

effective teaching can take place in rote learning environment (Schaathun, 2022). Learning of routine procedures does not also functioning well through rote learning, as learners just follow the rules like robots with poor memories (Hiebert & Stigler, 2023). Most of their teaching of Number Patterns in many mathematics classrooms is rote learning. Learning through understanding needs to be the approach adopted in every mathematics classroom. Mathematical procedures can be simply learnt by rote learning without proper understanding which exposes the lack of understanding of most teachers (Herscovics, 2018).

Number Patterns like all other topics in mathematics need inductive and deductive reasoning and approaches. Mathematical reasoning can be either inductive or deductive (Rott, 2021). Inductive reasoning just draws conclusions from specific things (Borgstede & Scholz, 2021). In deductive reasoning, valid conclusions are based on previously known facts and deductive reasoning can be a valid form of proof, how mathematical proofs are written (Atta et al., 2015). Furthermore, learners' difficulties in understanding the Number Patterns concept are also traced back to the methods of teaching used by teachers and the lack of content knowledge by some few mathematics teachers. The researcher, therefore, saw it important to do the study about Number Patterns to address the challenges teachers are facing when learners transition from lower to higher grades.

2.7 Challenges During Transitioning from Lower to Higher Grades

Misconceptions have been identified as one of the cause of challenges teachers have in using Number Patterns concepts from primary school to secondary school level. Misconceptions occur when learners are taught incorrect things or when learners captured things incorrectly and is a concern for mathematics teachers (Suprapto, 2020). Misconceptions and errors could happen because of various reasons namely: learners' disposition to mathematics (Kusmaryono et al., 2019), teaching framework (Skott, 2019), teaching skills (Organization of Education Economic Cooperation and Development [OECD], 2019), learners' preconceptions (Diyanahesa et al., 2017), limited understanding (Saputri & Widyaningrum, 2016), lack of appropriate modelling (Blazar & Kraft, 2017), and lack of higher-order thinking skills (Kusmaryono et al., 2020). Misconceptions in Number Patterns are associated with inaccurate ideas that learners develop during teaching and learning due to a lack of clarity in learning of

concepts (Kshetree, et al., 2021). These misconceptions are rooted in the prior knowledge, which were generalized inappropriately (Im & Jitendra, 2020). They considered either that what they are doing is correct or are not sure what they are doing (Neidorf et al., 2020). “The persistent misconceptions may interfere with learners' ability to understand mathematical concepts and may cause a frequent repetition of the errors.” (Im & Jitendra, 2020). This study will help to find these misconceptions and help to minimise the challenges teachers have as learners’ transit from lower grades to higher grades.

However, Adiredja (2019) argues that misconceptions are very resistant to change and stem from learners’ prior knowledge. Teachers in the higher classes always blame teachers from the lower grades and associate all misconceptions, gaps, and errors with them (Beach, 2021). Misconceptions and errors in Number Patterns are the main cause of misunderstanding of mathematical concepts that lead to challenges in teachers when the topic is taught the classrooms (Bowers, 2021). Misconceptions and errors are inseparable which occur because of errors that happened at the same time errors are a result of misconceptions. Errors are therefore symptoms of misconceptions that learners have and are not easily erasable in the mind of the learners like misconceptions (Chen et al., 2023). Misconceptions and errors occurring in the teaching and learning of Number Patterns is one of the processes of how the challenges affecting teaching of number pattern concepts at secondary school level engulfs the whole teaching and learning of the topic and the mathematics at large.

According to Rong and Mononen (2022), there are eight types of errors i.e.: visual-spatial, comprehension, transformation, procedural, factual, measurement, relevance, and presentation errors. Steuer et al. (2013) emphasised that errors are often perceived by students as self-threatening and not learning opportunities. Errors affect many learners in the class as they feel embarrassed after making errors known to other learners. Many learners keep quiet for fear of ridicule from fellow learners. The underperformance of Number Patterns in schools is attributed to factors of misconceptions and resultant errors (Khalo et al., 2022). Misconceptions and errors in mathematics including Number Patterns created in classes before matric greatly contribute to understanding and poor performance at the exit of basic education (Chihambakwe, 2017.

Some misconceptions and errors emanate from language switching occurring in the entrance of intermediate phase. Language switching in grade 4 confuses learners and contributes to underperformance in mathematics (Robertson & Graven, 2020). In all examination moderators and other diagnostic reports, there are misconceptions and errors identified and shared with subject teachers (DBE, 2016). It is the diagnostic reports that provide suggestions for improvements. Many researchers agreed that mathematics is poorly performed compared to other subjects (Verster & Sayed, 2020). From the 48 countries who participated in TIMSS 2015, South African students were the worst compared to other countries (Graham et al., 2020).

Many learners do not pursue mathematics at the tertiary level due to various constraints including under performance in the subject (Jojo, 2019). As much as my experience as a leader of teachers in my district and internal moderator in my province, it seems that Number Patterns receive less attention from curriculum planners and developers. It can be argued that the current trend in mathematical inquiry is that teachers are not teaching Number Patterns in the correct way that it should be taught. It must be emphasised to mathematics teachers to use visual representations like pictures, diagrams, graphs, and real patterns in the development of mathematical thoughts when teaching Number Patterns (Andri Nugroho, 2023). By so doing the challenges in teaching mathematics and Number Patterns as such will be minimized. In order to close the gaps created by other researchers the researcher saw it essential to conduct this study about Number Patterns teachers' challenges at secondary school levels in the Amajuba district of KwaZulu -Natal.

2.8 Summary

This chapter discussed the Mathematics Curriculum in South Africa, Mathematics teacher, Mathematics teaching, Developing Understanding of Mathematics, Number Patterns, and challenges encountered during transition of learners from lower to higher grades. The next chapter discusses the theoretical framework.

CHAPTER 3: THEORETICAL FRAMEWORK

3.1 Introduction

In the previous chapter related literature concerning the mathematics curriculum in South Africa, mathematics teachers, mathematics teaching, developing understanding, Number Patterns, and misconceptions in the mathematics classroom were discussed. This chapter will be discussing the theoretical framework, exploring constructivism, features of constructivism, constructivism and the learning of mathematics, constructivism and the mathematics teacher. Constructivism will be integrated with the problem, the literature review, and the methodology. learners and learning, social constructivism, social constructivism and learning mathematics. Integrating social constructivism with learners and learning will be included and ends with the summary.

3.2 Exploring the Theoretical Framework

This study researches teachers' challenges in using Number Patterns' knowledge that learners acquired in primary school at the secondary school level in Amajuba District. Challenges that the teachers have are the result of the interaction with the learners since the teaching process involves both the teacher and the learner. It was therefore important for this study to be supported by a relevant theoretical framework which is a set of concepts or theories that form the foundation of understanding. Theoretical framework used in this research have to assist and come up with solutions to help teachers overcome challenges they have in using Number Patterns concepts from primary school at the secondary level.

Constructivism must be used by teachers when teaching mathematics including Number Patterns (Spangler & Williams, 2019). There are several types of theoretical frameworks including constructivism. There is no single valid methodology, constructivists argue, but rather a variety of viable methods (Schofield, 2016). There are also various types of constructivism, used for research (Mohajan & Mohajan, 2022). The constructivism theory was used in this study as the lens for the study of the challenges teacher face when teaching Number Patterns transiting their learners from lower to higher grades.

3.3 Constructivism as a Theoretical Framework of the Study

Constructivism is defined as the theory where learners build their own knowledge and make their own representations (Garneau & Pepin, 2015) and encourages that learning must be always learner-centered so that all learners' reforming efforts can succeed. This chapter, therefore, discusses constructivism learning theory in relation to teaching and learning of mathematics, especially Number Patterns. According to Bada and Olusegun (2015), constructivist perspectives call for teachers to create intellectual environments that encourage students to actively participate in their learning. This can be achieved by interacting with content rather than passively receiving it. Constructivism influences the method of teaching and learning (Sulistyowati, 2019). Jean Piaget is widely regarded as the founder of constructivism theory (Sasan & Rabillas, 2022). Bada and Olusegun (2015) defined constructivism as an approach to teaching and learning based on the premise that learning is the result of mental construction, which means learners learn by infusing new knowledge with what they already know. Constructivists emphasise that learning is affected by the context in which something is taught and how it is received in the mind of the learner (Bada, & Olusegun, 2015).

Constructivism further suggests that humans construct knowledge and meaning from their experiences. It is not a specific pedagogy, but the objectives and formats of constructivism were considered in this study especially in relation to challenges teachers encounter when learners transit from lower to higher levels. Constructivism emphasises that learners do have pre-existing knowledge; hence teachers cannot simply transmit knowledge to learners as if they are empty vessels (Bada, 2015). Constructivism maintains the view of learning moving from individual to collaborative (Feyzi Behnagh & Yasrebi, 2020). In this approach learners are actively involved in the production of meaning and knowledge. Constructivism emphasises the pivotal role of an active rather than a passive learner which can be viewed as one of the challenges teachers have when their learners are transiting from lower to higher grades.

Constructivism theory as supported by Piaget's theory describes how humans learn and gain information (Sasan & Rabillas, 2022). It is a learning theory that is taken as the most fundamental teaching theory in the field of education and has a considerable impact on learners' learning processes. It declares that learners are not blank slates, and that knowledge cannot be

taught without the learner applying his or her conceptual skills to make sense of it, hence teachers will experience less or no challenges at all in teaching and learning of Number Patterns as learners are transiting to higher grades. This indicates that learners learn better when they are given opportunity to build their own personal understanding based on experiences and reflections. Kampouri et al., (2019) further emphasise that constructivism is a learning paradigm asserting that people actively construct new information from their experiences rather than learning from outside sources. Teachers will not encounter challenges if learners use the concepts learnt in previous grades productively in their current learning situation. Piaget also felt that when a person is confronted with a new learning scenario, he/or she draws on earlier experience to make the new situation accessible (Xu et al., 2021).

Olusegun (2015), defined constructivism as the idea that knowledge is constructed based on the learner's experiences. Teachers must be exposed to several constructivist educational theorists which can help in their classroom activities and the challenges they face in their teaching and learning as their learners' transit from lower level to higher levels. Golder (2018), clarifies that constructivism is a psychological learning theory that explains how people gain knowledge and learn. Since knowledge is acquired by interaction with content, learners need to be given opportunities to interact with content and develop their own world. Golder further emphasised that learners update their mental models to reflect new information as they perceive each new event, and therefore develop their version of reality. Subsequently, constructivism theory is said to be a philosophy that develops learners' logical and theoretical growth (Asmara et al., 2022).

Bada and Olusegun (2015), state that constructivism is a theory about how people learn, that is based on observation and scientific study. According to Gupta et al. (2022), the process of knowledge construction is performed in numerous ways: physical construction, which is performed through active learning, social construction of knowledge by making social settings, symbolic construction of knowledge which is done by making own representation of actions and theoretical construction of knowledge by explaining the ideas and things on their own. Constructivism describes the way that the learners make sense of the content and how it is effectively taught (Amineh & Asl, 2015). Teachers should consider what students know and allow their students to practise their knowledge. As a result, this will be further explored by discussing the features of constructivism, learning of mathematics and the mathematics teacher.

3.3.1 Features of Constructivism

This section draws the reader's attention to the formats of constructivism as the lens through which this study is viewed. It further displays how these formats inform the research and the reason why the researcher opted for using constructivism. However, it is necessary to allow learners to build knowledge as constructivism advocates that learners construct their learning by drawing from prior knowledge which this study intends to explore if the challenges teachers face is directly linked to learners' lack of prior knowledge. Constructivism creates strategy which enables the learners to gain knowledge through correlating their previous knowledge (Sulistyowati, 2019). In addition, Orlando (2013) noted that the term constructivism was initially used to describe a learning theory. Sulistyowati (2019), further described constructivism as always learner-centered whereby the teacher plays the facilitator not as the resource person in the teaching and learning processes.

The main conception of constructivist theories is that learners create their own knowledge through their own experience. Knowledge is not acquired but is constructed by learners, denoting that learners construct their meaning building on prior knowledge. Knowledge is gained through classroom interaction, implying that social connection enhances learning, (Pashkova-Balkenhol et al., 2019). When learners are in possession of previous classes' knowledge there will be no challenges for teachers as learners' transit from lower to higher classes. Constructivism theory has various broad branches, including those based on philosophical theories of learning and those concentrating on psychological ideas (Olusegun, 2015). Structuring, restructuring, and the organisation of ideas for meaning making are the tasks of constructivism (Hayes, 2020).

Constructivism has several versions, supported by different assumptions. and is used to describe learning, teaching, curricula, and assessment (O'Connor, 2022). It might also have a philosophical or epistemological connotation. Given the above statement of constructivism, the researcher concluded that constructivism fits in this study as it addresses the challenges teachers have when teaching Number Patterns to their learners transiting from lower classes to higher classes. Constructivism supports learner-centered learning in every classroom which is addressing challenges teachers have when teaching Number Patterns at higher levels

(McWilliams, 2016). Therefore, this study used constructivism to effectively explain the problem under study. As was stated by McWilliams (2016), the choice of constructivism in this study is grounded in the fact that it addresses challenges and gaps of Number Patterns in our classrooms, whereby learners need to have confidence in their learning and begin to work independently. According to the constructivism theory learners in higher grades should not encounter difficulty recalling or remembering what was taught to them in the lower grades.

According to Plucker et al. (2021), teachers are expected to be the drivers of the learners' minds during the process of teaching and learning. Constructivism theory is congruent with the learner-centered approach. Consequently, it is imperative that teachers adopt the constructivism theory and that they facilitate the teaching process instead of standing in front of the class and lecturing to learners. This implies that learner-centered approaches should be used in every classroom. The learners need to engage in the planned activities building from what they already know, and move towards new knowledge as they transit from lower grades to higher grades. Teachers and learners will work collaboratively in a developmental process eventually.

3.3.2 Constructivism and Learning Mathematics

According to Shah and Kumar (2019) constructivism explain how knowledge is produced as well as how learners learn at the same time demonstrating significant success in promoting learning. They further argued that constructivist teaching has been misinterpreted and misused, resulting in learning that is neither challenging learners nor addressing learners' needs. Constructivism applies specifically to mathematics education and maintains that mathematics should be taught emphasising problem solving. Constructivism emphasise that there must be an interaction between teacher and students, and among learners themselves. Learners should be encouraged to create their own strategies for problem solving situations (Ngirish, 2015). Use of problem solving will eradicate the challenges teachers used to have when teaching learners in higher grades transitioning from lower grades. According to Altaftazani et al. (2020) learning of mathematics must be learner -centered and have a learning approach that makes learners always active in teaching and learning activities.

The researcher chose the constructivism theory as the framework for the study to explore teacher challenges when their learners' transit from lower to higher classes. Mathematics

learning must always be learner-centered to avoid unproductive lessons that will always have gaps and misconceptions. Learners' participation in learning activities increase as they become more active in their learning. Constructivist teachers must understand that learners learn by mistakes and that knowledge is acquired through mistakes (Kusuma, 2021). Teachers should therefore perceive mistakes as a source of learning and information. The four principles of constructivism in mathematical learning should be adopted in the constructivist classroom namely: Psychological structure that happens before and during start of the lesson; Background knowledge that develops before teaching formal mathematics symbols or concepts; Opportunity to find and form mathematical relationships and creating an atmosphere of thinking in the classroom (Kusuma, 2021).

This means that constructivism views learners as unique individuals possessing unique needs and complex backgrounds, therefore the teacher ought to assist learners to reach their goals (Cherner, 2020). Learners in a constructivist learning environment are expected to be active participants in the process of learning instead of being passive (Pritchard, 2017). Moreover, it is crucial to make certain that a constructivist classroom environment is safe and allows learners to ask questions and reflect on their process (Cherner, 2020). Knowledge should exist within the learners. Teachers also need to engage their learners in interactive activities. The learner's role in a constructivist classroom is that they actively participate in their learning (Pritchard, 2017). They need not wait for the teacher to give them responses to the activities assigned to them but rather be proactive.

Accommodation and assimilation of new knowledge with their present understanding are always encouraged. Reflecting on their own experiences is said to be vital to guarantee that they are in control of their learning process. Ensuring that new information that poses a threat to the learners' existing knowledge is accepted is empirical Motshwane (2018). Learners seem to be hesitant when they are faced with a situation wherein, they will have to abandon their established ideas; therefore, they reject the new information, which is discouraged. It is critical that learners put their ideas, abilities, and knowledge to the test through relevant tasks. This will minimise the challenges teachers have in learners applying previous knowledge in their new lessons.

Through Constructivism individuals construct what they have learnt and understood. Piaget and Vygotsky have greatly influenced constructivism and form the cornerstone of the theory (Matsumoto, 2022). It can be argued that constructivism must be adopted by all teachers in their teaching and learning processes for any mathematics topic. In constructivism, learner-centered teaching methodologies are encouraged. As a result, teachers are advised to employ learner-centered constructivism approaches as it is grounded in that knowledge and skills are not something that can be passed down from teacher to learner, rather they are the result of learning activities done by learners themselves in small heterogeneous groups or individually (Montgomery, 2020). Learning is not a product that learners acquire passively but an active, iterative process (Mogavi et al., 2023).

Constructivism's greatest significant contribution to education may be its emphasis on learner-centered learning (Bada & Olusegun, 2015). Teaching is a method of engaging the learner in interaction and co-operation. It is facilitating individual and social knowledge building focusing on "learner-initiated inquiry and exploration" rather than just conveying knowledge or teachers' interpretations of meaning to the learner (Paulo & Tilya, 2014). This means that teachers should adapt their teaching and learning activities to accommodate individual requirements as well as disparities in ability, prior knowledge, and motivation. Learner-centered techniques are founded on a constructivist perspective of learning. Learners develops their learning process based on prior experiences, frequently in collaboration with others (Almodiel, 2022).

Furthermore, it is affirmed by stating that, according to constructivists, the learner should be at the center of the learning environment (Bada & Olusegun, 2015). Teachers should become more creative in introducing concepts in their lessons to facilitate effective classroom environment and be more engaging (Ariode et al., 2020). It is a philosophy that emphasises the importance of the learner. Learner-centeredness is a teaching approach that shifts the focus away from the teacher as the center of instruction and so the primary focus shifts from teaching to learning. Learner-centered teaching and learning emphasise the importance of students' prior experiences, examining individual needs and interests, encouraging active involvement, developing higher-order thinking abilities, and supporting lifelong learning (Zhu et al., 2020). Learners are treated as individuals in a learner-centered setting, and they work alone and in small groups to address real-world challenges.

This implies that learners personally construct knowledge, drawing from their existing knowledge. The learner-centered design aims to make learners more effective by encouraging them to engage in active exploration, building, and learning rather than being passive recipients of information (Bada & Olusegun, 2015). Learner-centered teaching and learning emphasise the importance of students' prior experiences, examining individual needs and interests, encouraging active involvement, developing higher-order thinking abilities, and supporting lifelong learning. Constructivism's greatest significant contribution to education may be its emphasis on learner-centered learning (Matriano, 2020). Constructivist perspectives call for teachers to create intellectual environments that encourage learners to actively participate in their learning by interacting with content rather than passively receiving it, to engage in critical thinking, to foster the development of understanding/construction of knowledge and skills, to take ownership of their learning, and to emphasise the importance of long-term learning (Gurjar, 2020). Mathematics teachers play a significant role in their teaching and learning and they must understand what learners need to learn and the strategies to help them (Bature, 2020).

3.3.3 Constructivism and the Mathematics Teacher

The teacher does not assume a role of an expert who knows everything instead the teacher works together with learners, affording them a chance to express their ideas. This is confirmed by Olusegun (2015), in mentioning that by creating a school climate that emphasises collaboration, constructivism aids, social and communication skills. Teachers are encouraged to practice expressing their thoughts properly as well as successful collaboration on activities. Four components for development are creativity, collaboration, communication, and critical thinking (Beswick & Fraser, 2019). Out of the four important components collaboration is the most important. Collaboration is not meant only for teachers, but also applies to learners. This is confirmed by (Qamar et al., 2022), who assert that learning must transpire from teacher to learner, learner to teacher, and learner to learner. Participation in learning activities is vital, as evidenced by collaboration. It improves learners' skills, gives them possibilities, and assists them in comprehending knowledge and tactics. Teaching must also be collaborated with Information Communication Technology (ICT). ICT tools are identified as main factors for a successful and effective tuition in mathematics (Toma, 2021). The Covid-19 era encouraged many teachers to learn to use ICT in their daily teachings.

McCauley et al., (2018). elucidate that learners are encouraged to share control of the learning environment with the teachers' guidance, as well as the expression of the learning goals, design and management of their learning activities. This demonstrates the importance of collaboration mentioned earlier. Collaboration is of the essence in a constructivist classroom as learners and teachers work together. This relates to my study because to augment the new content, it is required that learners recall what they did in the previous classes. At the beginning of every topic, there must be a revision of content learnt in the previous grade. As learners are asked questions on the previous class's work they are slowly introduced to the new content. They are also granted an opportunity to deliberate on gaps and misconceptions with which they are confronted. When learners remember what was taught to them in the previous class, they are giving the teacher the liberty to flow with the lesson and engage them in the new content as quickly as possible.

Professional development and teacher qualifications play a major role in teaching of mathematics in South African schools (Goos et.al, 2020). It is important that learners are taught by qualified and knowledgeable teachers. Therefore, they will understand Number Patterns and other mathematical concepts easier as they transit from lower to higher classes. Teachers' qualifications and experience are always taken into consideration as they contribute greatly to learners' mathematics performance and everyday teaching and learning in the classrooms. Highly qualified and experienced teachers will not encounter challenges when teaching Number Patterns to their learners as they transit from lower to higher classes.

The teachers' role in the constructivist classroom is just to give guidance and generalise learners' solutions to build a more abstract understanding (Haataja et al., 2019). This is an important aspect of a constructivist classroom since the learners and teachers work together. Collaboration in the classroom is important because both the teacher and the learner create a broad picture of the learning environment (Murphy et al., 2023). The teacher plays a vital role in the process of learners acquiring important knowledge to be used throughout his/her learning process. Number Patterns are understood and easy when learners are engaged in working together without interference of the teacher. That means learners must use their problem-solving skills in any problem when dealing with Number Patterns which implies conceptual understanding and interconnections of Number Patterns learnt in lower classes are of vital

importance in secondary teaching and learning. Learners should be given opportunities to apply what they have learnt in the new situation through constructing knowledge in their minds.

Collaborative discourse and communication within a community bring brains together, either directly or indirectly, to stimulate deep thought and cross-fertilization. Interacting with others and with learning materials appears to be essential for learners to develop knowledge internally from these perspectives (Kubheka, 2018). Optional cooperation, flexible partnership, and collaboration are three advantages of collaborative learning (Kubheka, 2018). Optional collaboration refers to a situation in which people are free to work alone but are also permitted to work in small groups if they so wish.

3.4 Integrating Constructivism with and within the Study

Collaborative nature of learning focuses mainly on constructivism theory. Looking at the challenge's teachers have in teaching Number Patterns in collaboration with constructivism it can be concluded that through constructivism these challenges can be overcome. The diagnostic analysis for mathematics by moderators in the 2020 report discovered that there is no collaboration of teaching Number Patterns in mathematics classrooms. It looks like teachers are not emphasizing the difference between the position and the value of a term in a Number Pattern sequence. They further discovered that learners cannot solve Number Patterns word problems involving real-life situations, which shows a lack of collaboration amongst teachers, learners, and the societies in which they live. It was also discovered that learners cannot integrate other topics like inequalities or simultaneous equations with Number Patterns.

Collaboration is a situation in which more than one person works together toward achieving a common goal and is a component of constructivist pedagogy that is a learner centered. Teachers are engaged in discussions with learners allowing them to build their knowledge, work, observations, and perspectives, as well as new content since learning is a collaborative process that builds on the learner's prior knowledge. In most activities, learners work in small groups and knowledge is observed as self-motivated, constantly changing with our encounters (Olusegun, 2015). The constructivism theoretical framework is integrated by the researcher with different main parts of this study viz. problem; literature review; methodology, analysis, and findings.

3.5 Integrating Constructivism with the Problem

It was discovered through this study that there is a problem with mathematics performance in Amajuba District as well as many South African schools. Analysis reveals that teachers are under pressure in terms of curriculum coverage. They have to work within restricted timeframes in order to meet the requirements of the ATPs. Rushing to be on par with ATP make them leave their learners behind (Du Plooy, 2015). Looking back to 2010, it is noticeable that the highest pass rate in mathematics is 59.1% (DBE, 2016). The department is trying to resolve the problem of mathematics in schools. Too much money is spent on uplifting the standard of mathematics in the country with no improvement.

Teachers and learners are supported by the department but no improvement of results or changes emerge. Teachers spend weekends in hotels and learners attend 7 days a week and during holidays but no improvement occurs. Some learners are taken to camps for about more than 12 hours per day during their holidays with no better results. The problem of mathematics poor performance is a problem that needs to be handled correctly and properly. That is why the researcher decided to do this research to address challenges teachers have as they teach mathematics to their learners transiting from lower to higher classes.

ANA emerged trying to deal with the gap occurring during the transition from primary to secondary. The Annual National Assessment (ANA) was an attempt by the DBE to measure the quality of schooling in the lower grades with the intention of improving grade 12 results (DBE, 2011). According to the Minister of Basic Education, Angie Motshekga (2011), ANA was expected to have four key effects on schools as follows: (a)to expose teachers to better assessment practices; (b)make it easier for districts to identify schools in most need of assistance; (c)encourage schools to celebrate outstanding performance and; (d)empower parents with information about their children's performance (DBE, 2011). The ANA test scores revealed and confirmed that mathematics is poorly performed in the primary schools and grade 9 learners in South Africa (Du Plooy, 2015).

This study focused on exploring mathematics teachers' challenges in using primary Number Pattern concepts when transitioning to the secondary school level in Amajuba district schools**.** The goal of constructivism is to improve collaborative learning (Lan, 2021). According to Orak

(2021), learners with varied abilities and experiences should engage in projects and conversations to reach a common understanding of the truth in a particular topic. To improve mathematics results and the performance in number patterns constructivism theory need to be practical in all mathematics classroom. It is essential to know what the learners did in the previous grade. In mathematics teaching, there is a link and continuation of content from one grade to another. The handover tool helps the teachers in the receiving grade to see if there were gaps or topics not taught in the previous grade. The use of handover tools during mathematics teaching links the subject and mediates work done in the previous grade and hence answers the question of topics not covered or not done correctly.

Constructivists make it a point that the focus in the classroom is on learners rather than on teachers. This is the practice that the researcher suggests should be adopted by all teachers since it is the learners who must learn not the teachers. In a constructivism classroom, the teacher's role is to encourage and support conversation. Subsequently, the principal emphasis of the teacher should be on guiding learners by asking questions leading them towards developing their conclusions on the topic (Bada, 2015). Constructivism benefits are that learners become actively involved in their learning. It has been observed that learners like learning more when actively participating rather than being passive listeners. They listen and forget but do and remember.

The first question is what challenges do mathematics teachers have in using number pattern concepts from primary school at secondary school level? The second question is how do teachers use their knowledge of number pattern concepts from primary school at secondary school level to overcome challenges? The third question is how do these challenges affect teaching of number pattern concepts at secondary school level using their primary school knowledge? All three questions are addressed in the constructivist theoretical framework. The study explores teachers' challenges in using primary Number Pattern concepts when transitioning to secondary school level. It is essential to view performances of learners as they progress from lower to higher classes. This then helps to overcome challenges and teachers stop blaming each other when gaps emerge as learners progress to higher levels of learning.

3.6 Integrating Constructivism with the Literature Review

There are multiple constructivists philosophers and theorists found in literature, but the following constructivist educational theorists are highlighted by Lev Vygotsky, who introduced the Zone of Proximal Development (ZPD). Over and above ZPD, Vygotsky talks about Scaffolding which refers to changing the level of support to meet the ability of the learner (Kim & Han, 2022). This theory encourages learners to work independently and measures the ability the learner acquired in the previous grades. The second theorist is Jean Piaget who introduced schemas which define the things that a child already knows. Piaget's schemas are developed through the complementary processes of assimilation and accommodation (Zhiqing, 2015). Constructivism suggests that humans construct knowledge and meaning from their experiences (Olusegun, 2015). Furthermore, constructivism views learners as actively constructing knowledge instead of passively receiving it from the world around them (Davis et al., 2020)

In this study, the challenge teachers have in the classrooms is the connection of new Number Pattern concepts to the new content. Jerome Bruner drew the readership's attention to the Spiral Curriculum which means learners can address problematic topics (Boladola, 2018). Learning from this theory it is acknowledged that the Number Patterns existing content knowledge needs to be revised before the new content is introduced. Piaget (1998) explained that assimilation and accommodation are the main conceptions. A learner sometimes fails to connect the old and new knowledge. The formation of misconceptions as a result of misinterpretation and poor linkage of assimilation and accommodation causes challenges in teaching Number Patterns in secondary schools (Ojose, 2015).

Individuals gain new perspectives as a result of assimilation, reconsidering past mistakes and assessing what is important, finally altering their minds (Olusegun, 2015). On the other hand, accommodation entails reshaping the environment and new experiences into existing mental capabilities (Olusegun, 2015). ZPD theory was clearly explained by Ha (2022) as represented in the model that follows in Figure 3.1

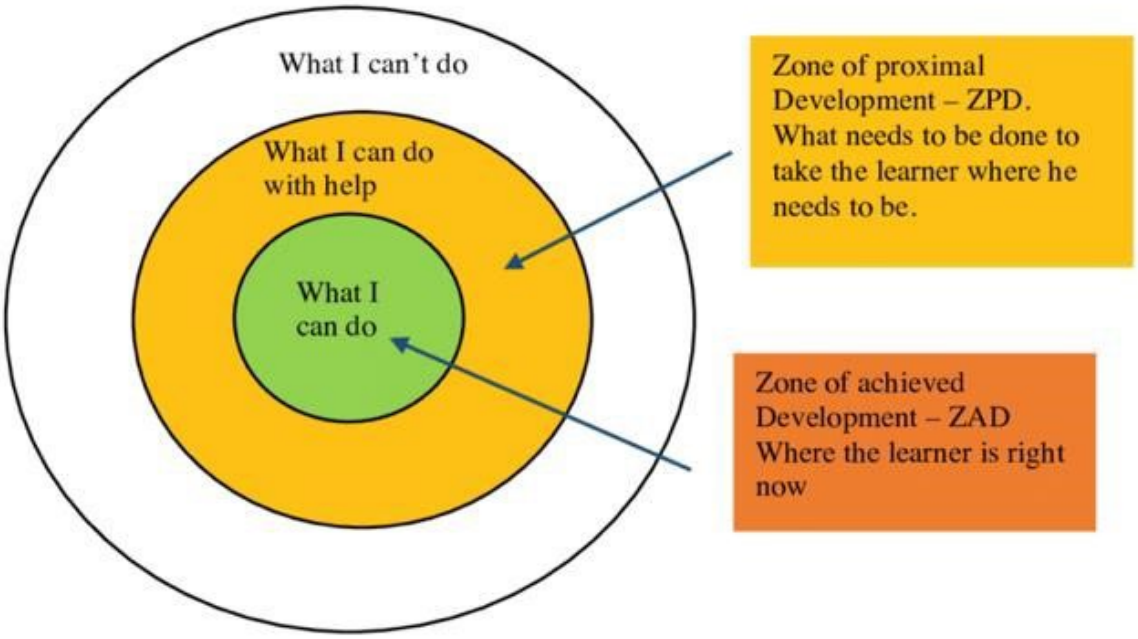


Figure 3.1 Lev Vygotsky Zone of Proximal Development by Dr Serhat Kurt cited by Ha (2022 p. 203)

The psychological foundations of constructivism can be traced to Jean Piaget's (1896-1980) developmental work. Constructivist attention to memory generally stems from the importance of viewing identity as a social understanding (Deacon, 2022). Piaget is said to be one of the theorists among cognitive constructivists and his theory laid a strong foundation for constructivism learning theory (Olusegun, 2015). Learners must be encouraged to construct their knowledge so that they can put their knowledge into context through experience.

There are many more constructivist theorists, such as Dewey (1998) who was an American philosopher and teacher. Dewey emphasised that when learners are involved with reflecting upon realistic problems to resolve their internal discord, they reconstruct the situation, which in turn re-establishes their authenticity and self-concept. Learners transform and come to be new people with the potential for new cycles of imbalance, problem exploration, resolutions, and reconstruction. Learners must be provided with problematic practical situations compelling them to face previous understandings to solve the current problems (Hanley et al., 2020).

Dewey introduced the project method which is a constructivist approach grounded on the principle of learning by doing and learning by living. Dewey's influence on constructivism was that learners' previous experiences assist them in learning new ideas (Westbrook et al., 2018). John Dewey was a great supporter of learning by doing instead of learning passively (Petry, 2018). According to his beliefs, each child is active, inquisitive, and someone who always likes to explore. He emphasised that children need to interact with other people, including peers and adults, and not exclude working alone. Dewey's theory was clearly illustrated by Petry (2018) as represented in the model that follows in Figure 3.2

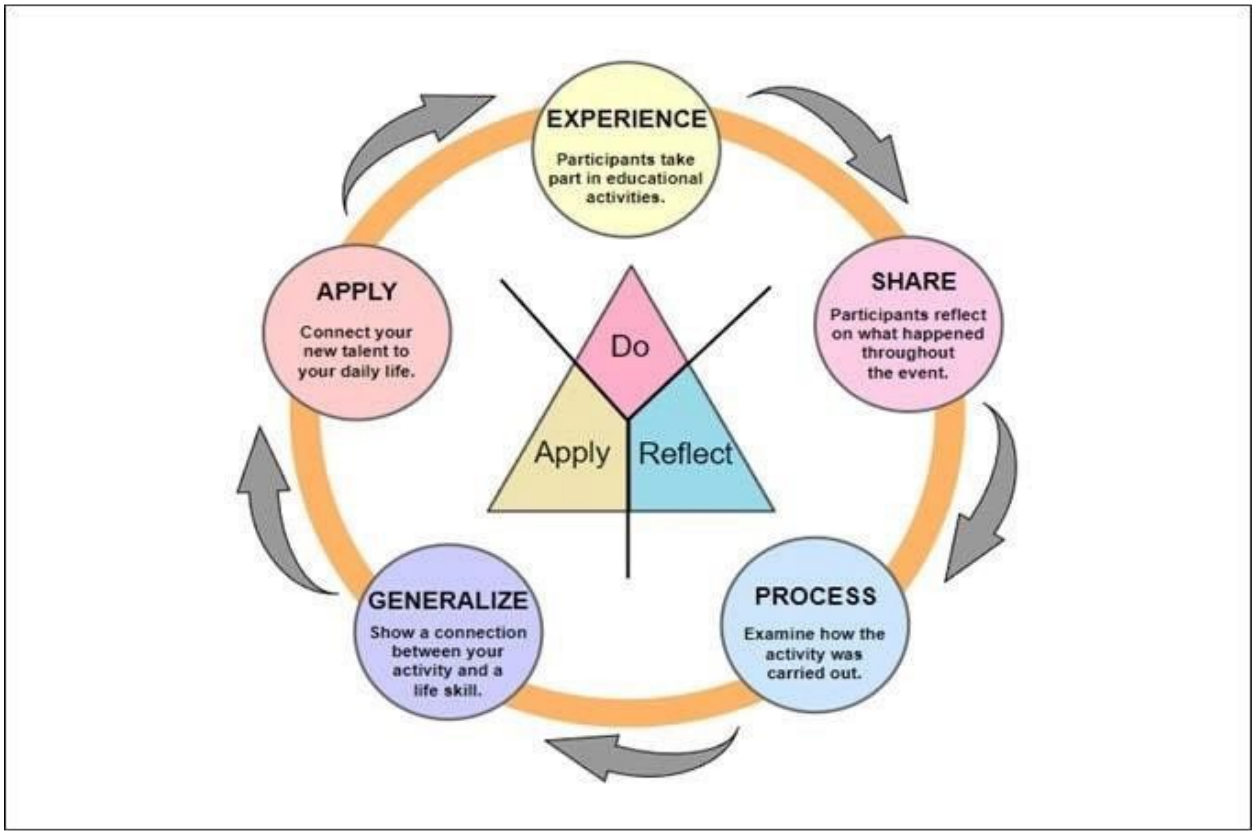


Figure 3.2: Dewey's theory illustrated by Honneth and cited by Petry (2018 p. 87)

Some researchers classified teachers' beliefs as learner-focused, content-focused, and classroom-focused (Belbase, 2019). The learner-focused beliefs emphasise engaging learners in the construction of the meaning of what they have learnt (Belbase, 2019). There are also challenges like scarce resources evidenced in rural and previously disadvantaged schools that affect effective teaching and learning. (Buthelezi, 2018). Teachers have learnt improvisation,

innovativeness, and creativity. They can produce good results under all the abnormal situations in which they find themselves. The ability to keep teaching with limited resources is an achievement that needs to be commended to all teachers in South Africa especially those from previously disadvantaged schools.

Active learning is defined as the provision of learning activities that demands learners to actively participate not just physically but also mentally in a variety of ways, rather than absorbing knowledge. Constructivism views learning as an active, contextualised process of building knowledge (Singh et al., 2021). Furthermore, knowledge is built based on personal experiences and environmental assumptions. Learners need to be actively involved in the process learning. Information and knowledge need not be passively received. Learners must be engaged in discussions in the process of constructing knowledge. Lai (2015) reinforces this when stating that learning theory and constructivism of knowledge can be applied to diverse learning programs.

The learners engage in informal activities which assist them in the acquisition of understanding. This is supported by Blumberg (2018), who states that in a constructivist classroom learner must be challenged to embrace individual differences. Learners raise their readiness to learn, find new concepts, and construct their knowledge through a range of activities through constructivism learning. These activities can be written, reading, or thinking activities which they do by posing questions to themselves and analysing their techniques. Lai (2015) states that learners' active engagement and self-direction are crucial to problem-solving education, as is the learners' experience and worldview. In a constructivist classroom, learners eventually become experts who learn how to learn in a well-designed classroom environment. However, (Blumberg, 2016) has discovered that classrooms are still organised in conventional ways.

It is not possible for all learners to learn by a single method as learning differs from person to person and has a multi-dimensional structure, therefore multiple methods and techniques for learning must be used and individual characteristics of learners be taken into consideration to ensure quality teaching and learning (Karsli & Yigit, 2017). Use of multi-dimensional structures can change the status quo of the schools' results. According to Ozdilek et al. (2018), a better understanding of the subject also raises academic achievement. Jigsaw is a cooperative learning

approach that is employed in four phases which are an introduction, focused exploration, reporting and reshaping, and integration and evaluation (Phuntsh & Gyeltshen, 2022). Jigsaw cooperative learning approach further brings improvement in learning achievement as compared to traditional teaching (Garcia, 2021).

These are the learning approaches that can be used in a constructivist classroom ensuring that learners engage fully in the process of teaching and learning. This will assist in ensuring that teaching and learning are improved, which will have a favourable impact on learner achievement or improve learner performance that will work with their memories to store what they have learnt in their minds permanently. Concentration is on comprehending and thinking skills instead of rote memorisation. It focuses on teaching learners how to think and comprehend. Constructivism also promotes social and communication skills by emphasising collaboration and sharing of ideas in the classroom (Bada & Olusegun, 2015). Learners are given activities for learning regularly where they are encouraged to work in small groups, pairs, and individually (Bada & Olusegun, 2015).

3.7 Integrating Constructivism with the Methodology, Analysis, and Findings

Research paradigm, design, and philosophy are very important strategies that can be integrated with theoretical frameworks. The way research information was collected, and the targeted population will also help with the solution to the problem for this study. Constructivism theory focuses on human activity where the learner is the centre of learning, and the teacher is just there to give guidance and support (Blumberg, 2016). In questionnaires, the teachers were asked questions about challenges encountered when teaching Number Patterns in different grades. There was a need to observe how the teacher overcomes challenges of learners not remembering what was taught to them in previous grades.

Data collection instruments and procedures were in place and congruent with constructivism theory. Teachers were interviewed on how and why they have challenges when teaching Number Patterns. The study was also critically evaluated with its validity and trustworthiness within the theoretical framework in place. Teaching through constructivism is an effective way to teach as it encourages active and meaningful learning, and promotes learner responsibility (Panhwar et al., 2016). It can also be emphasised that methodology is understood as a bridge

between theory and data (Ravitch & Car 2019). It is essential for teachers to grow professionally towards a constructivist practice because constructivist teaching is beneficial in achieving desirable educational goals (Panhwar et al., 2016). Learners' are made actively involved in the lesson in the constructivist setting.

Lochmiller and Lester (2015) argue that methodology is particularly useful when researchers are focusing on a detailed study. Methodology was particularly useful to explore the challenges teachers have in their Number Patterns lessons. Therefore, the data collection, analysis and findings were very effective in this study and helped in overcoming challenges teachers encounter when teaching Number Patterns as learners are transiting to higher from lower classes. Guided instruction and problem-based learning methods must be infused into all the teaching and learning of Number Patterns. Guided instruction is a teaching method in which a teacher uses questions, direct explanations, and modelling to lead learners' thinking and encourage them to take more responsibility for completing a task (Silver & Woolf, 2015). Guided-instruction pedagogy has its own limitations (Moore & Cuevas, 2022).

Problem-based learning is a systematic method that comprises dialogues in large and small groups (Wijnia & Servant-Miklos, 2019). They went further to elucidate that the first step in problem-based learning is to talk about what you have learned so far and ask questions about a specific problem or topic. Co-operative learning, according to (Mathew & Krishna, 2020), focuses on individuals working together to attain a specific goal. In this method, learners switch roles as teacher and learner whereby learners teach each other and teachers also learn from learners (Manyama et al., 2016).

3.8 Constructivism with Learners and Learning

Constructivists advocate for learner-centeredness as opposed to teacher-centered approaches. Lojdová (2019) emphasised that the significance of avoiding the traditional methods and engaging learners in activities whereby the learning is no longer teacher-centered but learner-centered. The challenges teachers encounter when teaching Number Patterns have a direct bearing on the learning process, therefore, you cannot separate teaching from learning. Learners should take charge of their learning instead of being dependent on the teacher (Manyama et al., 2016). It is on this premise that constructivists suggest learning approaches that can promote

independence to learners as well as problem-solving (Li et al., 2023). Learning needs to take place in collaboration with peers.

Different approaches can be adopted by the constructivist teacher including guided instruction, cooperative learning, jigsaw, problem-based learning, inquiry-based learning, etc. (Yılgın, 2023). According to Fritz (2019), the constructivist method includes the following characteristics: learners construct knowledge starting with what they already know, discover what needs to be understood, and decide the quality and effectiveness of their quest through authentic assessment and application of the greatest ways to learn. A learner can comprehend the concepts, not just the content which is an imperative aspect of learning since it is the development, explanation, or other alterations of a concept (Su & Zou, 2022). The focus of the activity is changed from the teacher to the learners through learner-centered teaching methods. In Figure 3.3 clear indication that teaching is learner-centered as learners become the centre of teaching and learning with accountability, enquiry, discussion, collaboration, creation and reflection being important features around the process is given.

Figure 3.3: Learner-centered model adapted from Benson (2012 p. 67)

Constructivism learning theory promotes learners' learning which is believed to be the best way of making learning successful (Olusegun, 2015). According to Supena et al. (2021) constructivism thinking, creative thinking, communication, and collaboration are skills needed in the 21st century to strengthen teaching and learning processes. Strengthening learners' logical thinking implies that the learner will be competent to learn, drawing from previous experiences or knowledge. People acquire or develop information and form meaning depending on their experiences, according to this theory. Further, this assists when complex skills such as problem-solving, and critical thinking are dealt with accordingly. Having accepted that constructivist theory is one of the theories that advocates for the promotion of learning, it is thought vital to construct learning settings in which learners can see the subject they are learning (Anderson, 2022).

It is on this premise that Anderson (2022) identifies four essential learning environment features that must be considered when applying constructivist learning methodologies. The first

characteristic is that knowledge must be shared between teachers and learners, the second is the teacher's role in class, the third is sharing of authority between the learner and the teacher, and the fourth is forming small learning groups which consist of diverse learners. Learning takes place in the personal cognitive development zone that exists between what is previously known, what is unknown, and what one wishes to learn. Learning is most effective when one's comprehension corresponds to the stages of human development. Learning is questioning, learning, investigating, doing, and undergoing the process, based on experience (Fritz, 2019). The process of learning has structure and is neither random nor eclectic. Laddering, scaffolding, weaving, and dialogism are all examples of spiralling learning. The social milieu of individual performance and the interaction between the learners and teacher, as well as the learners' peers in culturally valued activities, all have a role in cognitive growth (Mustafa et al., 2019). Structured cognition and effective taxonomies should lead the interactive process of learning.

Knowledge sharing is a two-way process that modifies, and reuses ideas and information (Garcia-Sanchez et al., 2017). Sharing knowledge between teachers and learners is viewed as an important quality that is developed in learning environments (Osmani et al., 2017). The researcher sees sharing of knowledge as an essential aspect of the promotion of learning. It is vital for teachers to be important factors that build up the learning environment that accommodates different learning styles. Learners need to be motivated to accept responsibility for their learning (Darsih, 2018). Teachers must understand their function in the learning process and play their roles. In a constructivist teaching space, the central duty of the teacher is to assist learners to use their knowledge, building up from what they already know, and make their existence felt during the process of learning. Learners must be given the freedom to construct knowledge themselves without the intervention of the teacher. Teachers frequently teach in the way they were taught which is the traditional method. (Shah & Kumar, 2019).

3.9 Social Constructivism

Social constructivism emphasises that meanings and understandings of teaching and learning may increase and improve because of social encounters (Amineh & Asl, 2015). Under social constructivism meaningful understanding of mathematical concepts are constructed as learners learn from what they know to what they do not know. Number Patterns knowledge learnt from

previous grades needs to be remembered and applied to the new content as knowledge should not merely be transferred or transmitted from the teacher to the learner.

3.10 Social Constructivism and Learning Mathematics

Social constructivism combined with cognitive demands encourages that teaching of mathematics should use authentic problem solving through creative thinking using group work (Gonda et.al, 2020). According to Weinhandl et al. (2022), social constructivists consider the process of knowing as the intrinsic nature of social interchange that leads to higher levels of reasoning and learning. Socio-constructivist and reflexive learning are learning paradigms that approach problems in a particular way which is vital for mathematics teaching and learning (Bozkurt, 2017). In constructivism, socio-constructivist learning and reflexive learning are very important in learning mathematics (Weinhandl et al., 2022).

Constructivism views learners as unique individuals possessing unique needs and complex backgrounds, and the teacher ought to assist learners to reach their goals. Moreover, it is crucial to make certain that a constructivist classroom environment is safe and lets learners ask questions and reflect on their process (Cherner, 2020). Instead of being passive, learners in a constructivism learning environment are expected to be active participants working collaboratively in groups and given opportunities to think critically. The learner's role in a constructivism classroom is delineated and elucidates the need to actively participate in their learning and be in charge of their learning (Pritchard, 2017). Knowledge should exist within them and they also need to engage in interactive activities. They need not wait for the teacher to give them responses to the activities assigned to them. Accommodation and assimilation of new knowledge with their present understanding are always encouraged.

Reflecting on their own experiences is said to be vital to guarantee that they are in control of their learning process. Ensuring that new information that poses a threat to their existing knowledge is dealt with and attended to accordingly. Learners seem to be hesitant when they are faced with a situation wherein, they will have to abandon their established ideas; therefore, they reject the new information, which is discouraged. It is critical that learners put their ideas, abilities, and knowledge to the test through relevant tasks. This supports the issue of formative assessment as a learning activity.

The teacher's role is collaborative, embedded in cooperation, the pursuit of learners' interests and questions is esteemed, and primary sources of material and manipulative materials are examples of materials (Olusegun, 2015). Teachers engage in discussions with learners allowing them to build their knowledge, learners' work, observations, and perspectives, as well as examinations, are all considered in the assessment process since learning is a collaborative process that builds on learners' prior knowledge (Olusegun, 2015). In most activities, learners work in small groups and knowledge is observed as self-motivated, constantly changing with our encounters.

3.11 Summary

This study was underpinned by Constructivism and Social constructivism. Constructivism was outlined, zooming into its formation, and different theorists' and philosophers' ideas of constructivist learning theory. It was defined by drawing from different perspectives and different types of constructivism were examined. The origins of this theory of learning were explicated, with examples from Bruner, Vygotsky, Dewey, Piaget, and others. Constructivists claim that knowledge is constructed by the learner, based on prior knowledge that is very important for learners to easily understand new Number Pattern's concepts in a new situation. Objectives were explored in detail. This chapter went further to give details on how social constructivism was integrated with the learning of mathematics. The next chapter discusses the research paradigm, research design, research philosophy and strategies, data collection instruments and procedures, qualitative data analysis procedures, trustworthiness, ethical consideration, limitations of the study, and summary.

CHAPTER 4: RESEARCH METHODOLOGY AND PROCEDURES

4.1 Introduction

In this chapter the research paradigm, research design, research philosophy, and strategies, data collection instruments and procedures, qualitative data analysis and procedures, trustworthiness, ethical considerations and limitations of the study will be discussed.

4.2 Research Paradigm

The research paradigm has to be adopted in the study in order to improve its credibility and generalisability (Kankam, 2019). Research paradigm addresses and reflects the researchers' beliefs about his/her surrounding and refers to how he/she sees the world around him/her (Kivunja & Kuyini, 2017). Research plan is created and guided by the research paradigm (Ngulube et.al, 2015). According to Al-Ababneh (2020), research paradigm is composed of four elements namely: epistemology, ontology, methodology and axiology. Aim of the study, research questions, instruments used and analysis methods are all guided and structured by the research paradigm (Ngulube et.al, 2015).

Research can also be done to contribute new knowledge or inventions in a situation in place. It can then be concluded that through the research paradigm, framework and guidelines about the research must be provided It essential to understand the elements of the research paradigm listed above because they comprise the basic assumptions, beliefs, norms and values that each paradigm holds (Kivunja & Kuyini 2017). "Epistemology is about the description of how we know something and how we know the truth or reality of a thing" (Al-Ababneh, 2020). "Ontology deals with the assumptions we make in order to believe that something makes sense or is real" (Kankam, 2019). "Methodology is used to refer to the research design, methods, approaches and procedures used in an investigation that is planned to find out something" (Al-Ababneh, 2020). "Axiology is about the ethical issues that need to be considered when planning a research proposal" (Kivunja & Kuyini 2017).

The study is about identifypng challenges teachers have in teaching Number Patterns to learners when they transition from lower to higher classes. Through the research questions the challenges are identified, and the ways to overcome these challenges are also checked and the impact the

challenges have on the teaching and learning are closely investigated. Questionnaires, interview schedules, lesson observations and document analysis were effectively used to make this study a success. Qualitative research methods were used to find out more about how teachers use primary Number Pattern concepts at the secondary school level. In certain circumstances quantitative data analysis was utilised especially where statistics were needed. The qualitative data collection tools included questionnaires, interviews, observations, and document analysis**.** The qualitative data collection tools were designed to give opportunities for teachers to freely give their views. Qualitative research method was supplemented by quantitative in case there was need of statistics.

Deductive and inductive approaches were constantly used during this research. According to Azungah (2018) deductive and inductive approaches provide comprehensive quality in analysing qualitative data. In order to make sense of the whole set of data and to understand it, qualitative data analysis in both deductive and inductive approaches must be involved (Azungah, 2018). The deductive approach is whereby research mainly starts with a theory, forming concepts and coming up with the model at the end. Inductive approach starts with observations to develop theories and generalisations. Both approaches were utilised effectively in this study. The arrows in Figure 4.1 that are pointing in opposite directions show the relationship between theory and research from positivist and interpretivist perspective views. The model- theory continuum in Figure 4.1 clearly shows the difference between inductive and deductive approaches.

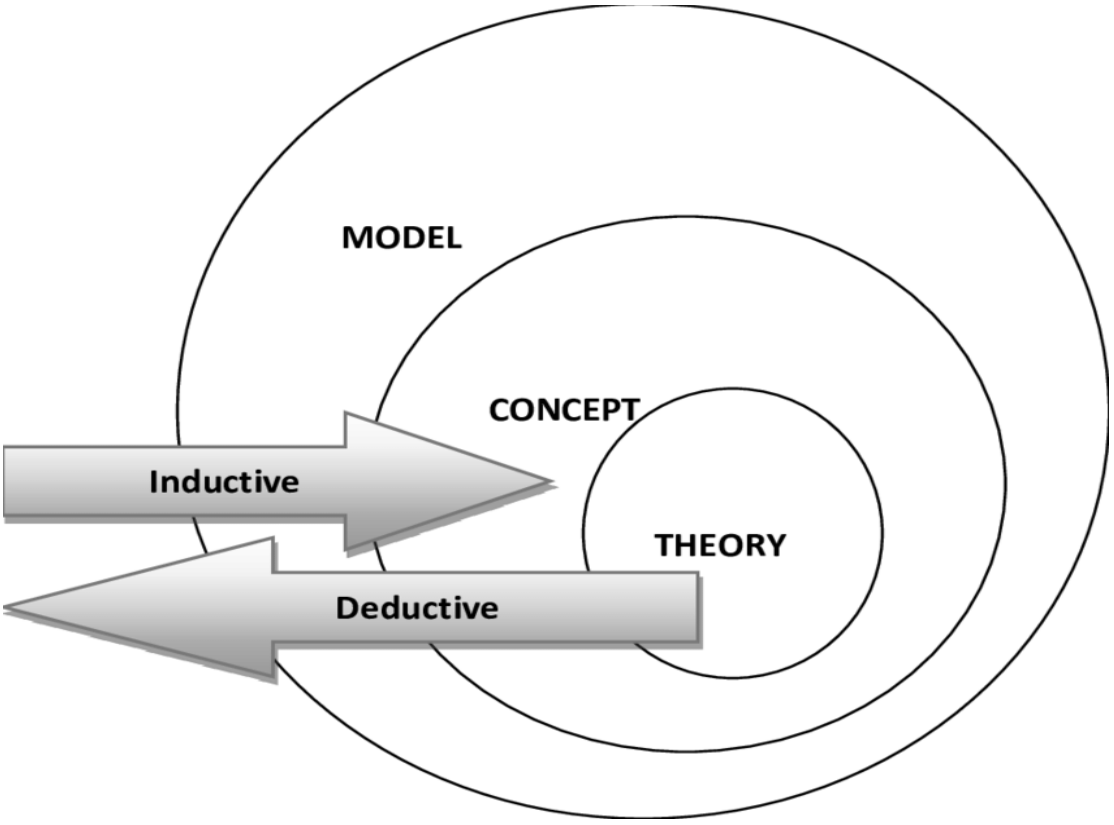


Figure 4.1: Model-theory continuum cited by (Ngulube et al., 2015 p. 4)

Positivism argues that reality must be examined with the use of strong interaction and perfect inquiry (Kamal, 2019). Qualitative research is always possible through positivist research, which makes it possible to generalise about the world and its reality (Mukherji & Albon, 2022). The constructivist paradigm believes that the methodology utilised in research should make the reader have anxiety to explore and find out more about what he/she learnt (Kamal, 2019).

The researcher who employs the constructivism paradigm uses the experiences collected to build and construct understanding from the data gathered to find the answers for the study (Thanh & Thanh, 2015). This research used constructivism as one type of qualitative research paradigm. Ndlovu (2021) highlighted that the qualitative approach gives exhaustive accounts that are essential for the constructivism paradigm to entirely understand and appreciate circumstances.

4.3 Research Design

In the qualitative research design the how's and why's are the prominent questions that are answered. Research design provides an appropriate framework for the study, and it is where the choice about the approach to be used in the study is made (Sileyew, 2019). The inductive approach is used frequently during this qualitative study because it describes and explores the collected data (Ngirish, 2015).

The study focuses on the challenges teachers have in using the Number Patterns knowledge learners acquired in primary transitioning to the secondary school level. It was observed how this topic affects the overall performance of mathematics examination papers. This study focuses on seven purposefully chosen participants who teach mathematics in primary and secondary schools, looking at the challenges they are facing when teaching Number Patterns in their respective schools and classrooms. According to the analysis done by (DBE, 2011) after every session of the matric final examination, it was observed that teachers are not doing well in teaching mathematics concepts including Number Patterns. This leads to a high failure rate of mathematics across the country.

One topic that learners are not doing well in mathematics paper one was identified during the end of the year grade 12 paper analysis, and that is Number Patterns (DBE Diagnostic Analysis, 2021). Researchers need to research why learners perform so badly in this topic and make recommendations that will assist teachers and learners to overcome this challenge. That is why I decided to research this topic. Seven teachers from seven schools participated in this research. Four secondary and three primary schools were selected as the sample of the study. In the secondary schools, one teacher from each phase namely GET and/or FET in the school completed the questionnaires. Three grade 7 teachers in the Senior Phase also completed the questionnaires. Highly experienced teachers were selected randomly to be part of the interviewed participants. Three participants from secondary schools and one from a primary school were selected for the interview and lesson observations. The teachers with greater experience in teaching the subject were given more preference than the teachers with less experience in selecting participants for the interviews. The data generated for this study used four stages explained as in Table 4.1:

Table 4.1 Stages of Data Generation (Own)

Stage	Tool(s) used	Participants
1	Questionnaires	Three teachers from primary and four from secondary schools
2	Interviews	One teacher from primary school and three from secondary schools
3	Lesson observations	One primary and three secondary school teachers
4	Document Analysis	Three teachers for primary and four from secondary schools.

The data for this research was collected through the teacher participants using questionnaires and interviews. This research intended to gather and analyse data regarding the perspectives of research participants supplied on the topic displayed in the beginning of the research. Questionnaires and interviews to generate the data from four secondary schools and three primaries in Amajuba district were utilised. Amajuba is one of the districts situated in Northern KwaZulu-Natal, about 350km away from Durban. One primary and two secondary schools were visited for lessons observations which was successful. During lesson observations it was noticed that some of the teachers were nervous and were unable to deliver their lessons freely.

Inductive and deductive approaches were used to analyse the data collected. Data was examined through interpretive analysis for patterns and themes. Research questions were phrased to answer questions on what and how, as demanded by the research design. As a qualitative study when data was analysed common responses were brought together. Moreover, this study was targeting at providing solutions for challenges identified when interacting with participants' responses.

4.4 Research Philosophy and Strategies

The research philosophy is the position of the researcher in which the reality is viewed, and assumptions about knowledge, methodology and value are considered (Khatri, 2020). According to Mauthner (2020), the nature of reality investigated and the reality knowledge are provided through research philosophy. Philosophical positioning of the researcher becomes a

philosophical dimension of the research (Khatri, 2020). Research philosophers are historically and culturally produced, and they are not only anybody's personal beliefs and assumptions (Mauthner,2020) The researcher will then be guided to pave the way for the entire process and the knowledge of research is then considered important to create research philosophy (Khatri, 2020).

This study explored seven mathematics teachers' challenges in using primary school number concepts when transitioning to the secondary school level within the Amajuba district. In this section, the process of data analysis in terms of definition and the processes involved was described before explanation of how the data was analysed. Data was presented in the form of tables, graphs, diagrams, and figures before being analysed to check for similar patterns and themes, which is referred to as the process of bringing order, structure, and interpretation to the data (TalkadSukumar & Metoyer, 2019).

Embarking on learner-centered methods in the classrooms help teachers to overcome the challenges they have in teaching and learning of mathematics especially Number Patterns. Mathematics teachers must strive to use teaching methods that are learner-centered, with the aim of improving student performance (Muchiri & Njenga, 2020). Learner-centered methods promote active learner participation which is key to learning of mathematics. Learner-centered approaches have been observed to be more effective in teaching of mathematics, though it can be time consuming and less productive if not well planned (Muchiri & Njenga, 2020).

4.5 Data Collection Instruments and Procedures

Data collection for this study was done through questionnaires, interviews and lesson observations. Data is effectively collected using questionnaires and interviews (Rahmani & Mandasari, 2021). The questionnaire and interview questions were mainly focusing on the challenges teacher experience in their teaching of Number Patterns in their classrooms. Through the observation of teacher in the classroom it can be seen clearly whether learning takes place in the classroom or not (Yusrina & Bima, 2020). The researcher developed observation schedule to describe and investigate effectiveness of teaching Number Patterns in the primary and secondary schools. The design of lesson observation schedule was drawn upon the aspects of

teaching using problem solving and the tasks given by the teacher to the learners. Through these data collection instruments, the three research questions were answered.

There were so many things that transpired during the collection of data. Teachers were not comfortable for interviews and lesson observations. The most daunting experience for the teachers was recording of interviews and in class lesson observations. This motion was evident from teachers' responses during interviews and class visits. I needed to explain to the participants that the research had no influence on our working relationship as subject advisor and teacher. It was further explained that all information that was shared with me was confidential and would not be shared with anybody for any particular reason. There are many dissatisfactions and serious concerns participants raised during the interviews about what transpired at their schools. It also become apparent through the questionnaires and interviews that teachers needed content development in some Number Patterns' topics. Moreover, the lesson observations reflected that most of the participants were not confident with the subject matter on Number Patterns.

Questionnaires were effectively used in the study which were designed to collect data from different teachers teaching in different schools and different phases. Simple questions were asked whereby participants responded through ticking in the box or yes or no. In cases where participants must write something it was just a one-word response where the participant must list challenges and possible solutions in short. Questionnaires were administered with confidentiality assuring the participants that their responses are anonymous. The participants were further encouraged to be truthful in their responses. Questionnaires were hand delivered and again hand collected to avoid loss. Questionnaires are used to measure outcome variables, which can compromise validity especially when questionnaires are used to measure actions (Fischer et al., 2020)

In a qualitative research, interviews are utilised to collect data and semi -structured interviews were considered for this study. Interview questions were prepared and put on the template to collect data and participants were given the questions seven days before the interview date. They must prepare themselves in order to respond appropriately and remember detail. Participants were allowed to use their notes during the interview and were also assured that

their responses will remain confidential. Though confidentiality is far from assured even if professional interviewers conduct the interviews, participants must always be given hope and trust that the information given will remain anonymous (Patten, 2016).

Lesson observation was also prepared by the researcher prior to the actual lesson observation for the secondary teachers in charge. Teachers must fill the observation template and submit before the class observation. Teachers feel very uncomfortable when they have a visitor in their classroom and being nervous makes them not perform to their normal standard. Teachers also feel shy to expose their learners' previous achievements. Document analysis was also utilised to find out how the learners were performing in the previous years in mathematics. Teachers were also very reluctant to disclose their schools' results as requested. I was very patient with them until they complied.

4.6 Qualitative Data Analysis and Procedures

Qualitative data analysis was preferred more than quantitative data analysis. This study was more of words than numbers hence falls under qualitative, however participants' point of view was always taken into consideration. Table 4.2 clearly distinguishes between quantitative and qualitative data analysis. Qualitative data analysis can be both deductive and inductive though the deductive approach is commonly used in quantitative, it can also be applied effectively in the qualitative data analysis (Ravindran, 2019).

Table 4.2 Common contrasts between Quantitative and Qualitative Research cited by Graue (2015 p.416)

QUANTITATIVE	**QUALITATIVE**
Numbers	Words
Point of view of researcher	Points of view of participants
Researcher distant	Researcher close
Theory testing	Theory emergent
Static	Process
Structured	Unstructured
Generalisation	Contextual understanding
Hard, reliable data	Rich, deep data
Macro	Micro
Behaviour	Meaning
Artificial settings	Natural settings

The study used questionnaires and interviews for data collection within the framework of qualitative research. The deductive approach in data analysis within the framework of the constructivist theory was adopted using the teachers' responses during data analysis. The interview data was used to clarify the teachers' responses to the questions. The researcher took the teachers' responses in the questionnaires singly and analysed them noting their common responses. Data collected was treated with great confidentiality to respect the anonymity of the participants.

Data that was collected was personally transcribed into written form by the researcher. The inductive approach was adopted to transcribe data from questionnaires, interviews and the observation schedule. Findings were made and written in this research study with subjectivity and without biasness. Teachers were raising critical issues that were handled accordingly and taken into consideration. All findings that emerged were communicated and discussed with participants involved with the hope that it will be useful and minimise the challenges teachers are having when teaching number patterns to their learners.

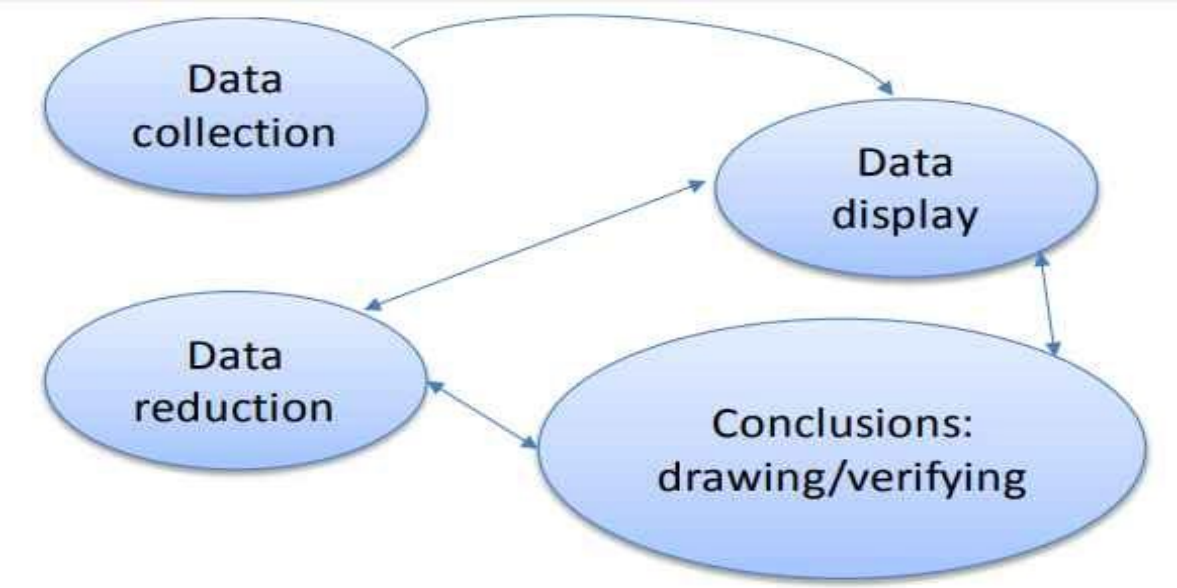


Figure 4.2: Components of Qualitative Data Analysis. Source: Cited by Mayer (2015 p. 174)

The model displayed in Figure 5 was used effectively during the analysis of data in this study. As the model shows everything starts with the collection of data and so I started my research by collecting necessary data using all the tools I prepared for collection of data. The next level of this model was data display which means data was now collected and placed on the table for analysis. The next level is conclusion whereby the data is analysed accordingly. The last level is data reduction whereby some analysing continues, and findings declared. According to Mayer (2015), data reduction occurs constantly during the analysis with the objective of reducing data without losing information. Data reduction and display are important steps in the model displayed in Figure 5 to assist in drawing and verifying of conclusions in the study (Mayer, 2015).

4.7 Trustworthiness

Trustworthiness is subdivided into four criteria. The four quality criteria namely credibility, dependability, conformability, and transferability are needed for qualitative research (Korstjens & Moser, 2018). According to Connelly (2016), trustworthiness is the degree of confidence in data interpretation including methods used ensuring quality of the study. However, Leung (2015) argued that as much as trustworthiness is needed for the study, there is a question of what constitutes trustworthiness.

Triangulation strategy was adopted for this study because of its diverse character. According to Hadi and Jose Closs (2016), triangulation strategy includes both credibility and conformability, reduces biasness and is not seen as the tool to check validity and labelling of data. Triangulation must be used from the beginning of the research until the end (Lemon & Hayes, 2020). Triangulation is when the researcher uses different sources in order to gain knowledge that is more reliable and is in the form of theoretical, investigative or methodological (Graue, 2015). Methodological triangulation is one of the most used types of triangulation (Graue, 2015). Data triangulation is the use of different data sources like questionnaires data, interview data and observational data.

Credibility of findings in relation to qualitative research needs to be ensured and used in all qualitative research (Noble & Smith, 2015). Credibility is the confidence in the truth of the study and its findings are very important and true (Connelly, 2016). Credibility is the degree in which actual meaning of the research is represented and the research purposes fulfilled (Moon et al., 2016). Data triangulation works closely with credibility. In data triangulation data is collected using different sampling strategies (Mayer, 2015). This study enhances the credibility through questionnaires, audiotape recordings used during the interviews, and information received during observations. Triangulation was used to increase credibility in the study.

Dependability is another quality criterion of trustworthiness that includes the aspect of consistency (Korstjens & Moser, 2018). In qualitative research consistency and stability of data gathering are defined in terms of dependability (Dodd, 2020). The data collected was compared to different sources to verify the consistency before being accepted. Whatever was discovered through this study was constant and can be equally the same when researched by another researcher. According to Noble and Smith (2015) for consistency to be confirmed an independent researcher should be able to arrive at similar findings when doing the same research. Findings of the similar studies done before this have similar findings which confirms dependability of this study,

Conformability is concerned with neutrality and establishing that the interpretation of findings is taken from the data collected. (Korstjens & Moser, 2018). Findings must be confirmed by other researchers doing the same study. According to Korstjens and Moser (2018) interpretation

should not be from anybody's preferences or viewpoint but be grounded in the data collected. Data collected through interviews, questionnaires, observations, and document analysis were analysed without biasness and transcribed to written form as is.

Transferability in qualitative research strongly emphasises that findings from one study can be applied to other settings or population (Daniel, 2019). Transferability is also defined as the evidence supporting the generalisation of the findings to similar settings (McLure et al., 2022). The description of the settings including the targeted population, demographic, socio-economic, sample strategy, interview procedures etc. was provided. This provision allows other researchers to apply their findings to similar settings and to other similar contexts.

4.8 Ethical Considerations

Ethical issues are important issues that researchers must solve to make research ethically accepted (Beh et al., 2018). However, ethics essentially includes good or bad judgments on processes related to seizing power or maintaining public power (Disantara et al., 2022). Ethics also assess how much benefit the policies issued by public officials to the public are. Some ethical issues arose at the beginning of the study involving the teachers teaching mathematics in certain schools. Permission was given by the principals and the departmental heads as well as teachers to continue with the study on their premises.

At the beginning of the research, there were signs that it would be difficult to work with teachers in schools as Covid 19 was at its peak. The University gave the researcher the go-ahead to conduct the study through Ethical Clearance. The study only started after the principals of the schools signed and accepted the study to access their schools. The principals allowed me to use their schools as the source of information. Informed consent letters were then designed and handed out to all participants involved in the study. This affected time frames in the completion of each instrument. Confidentiality and freedom to participate were clearly explained and guaranteed. Participants were ensured that information shared is confidential and cannot be shared or given to anybody else for any purpose. They were further informed that there are no rewards or incentives to be gained or given to the participants during the research period or after the completion of this study.

After the Covid 19 era teachers and schools were affected by the floods. Fortunately, none of the teachers participated lost any information collected. All ethical issues were resolved accordingly and none of them interfered much with the study.

4.9 Limitations of the Study

Every research study has its own limitations. The study was carried out in only seven schools in the same district which is not representative of the whole province or country, therefore it was not possible to generalise the findings of this study to other situations such as a full mathematics subject. Schools sampled for this study were from different settings, and working conditions and have different resources which may lead to some limitations. The schools were of the same quintile ranking with the teachers belonging to one race group. The results of the findings of this research would be different from this study if it was done with different kinds of schools and teachers, and from different parts of the province or country.

The was done during the Covid-19 pandemic which has strict restrictions. All participants and the researcher were learning and adapting to the new setup and restrictions of the country's systems. Some participants were sometimes not present and were complaining about the meetings since the study was mostly conducted under very strict restrictions. This was done to work around the issue of Covid-19, since we had to adhere to the health regulations, such as social distancing and being isolated at home. District officials were also part of the team which contributed to the participants being unable to express their concerns without restrictions due to the power differences of the individuals. The fact that the participants were also from one district also limited the scope of the research to very few schools compromising other schools that may have different conditions.

The four teachers sampled were further selected from the rest of the participants for the interview process which also posed limitation to implementing findings in a normal scenario. Another limitation of the study is the mathematical backgrounds of some participants that were selected from a school with more than one teacher. If a similar study was carried out in many schools from different clusters and districts, the results would be different. As a result, due to the small number of participants in the study, results cannot be generalised taking into consideration that there are other teachers in the twelve districts of KwaZulu-Natal. These

limitations, therefore, compromised the generalization of the results of the study to other schools, districts, and other provinces in the country and internationally. Other researchers can take advantage of these flaws to improve the study of challenges teachers encounter when teaching Number Patterns.

The researcher and the participants were aware of the confines of the study which could limit the validity of the research, since it was made clear. Another limitation of the study was that it was done for teachers who are sometimes not complying with sharing information. The participants sometimes were hesitant to contribute, even though the researcher clarified the goals and the purposes of conducting the research. Some teachers were reluctant to give the information as they thought it will be used somewhere against them. They did not allow me to observe their lessons because the researcher is one of the subject specialists in the area therefore I needed to explain clearly that this is just research, and their schools and names will not be mentioned. Some were even nervous when visited for lesson observation but eventually relaxed as the lesson progressed and were assured that the observer is not there to find faults but to research. Time was also another limitation in this study for the researcher who also had full-time work.

If there is a need to extend the scope of findings for future research, then the sample should be increased, and more teachers should be targeted from different parts of the province or country. The research would have had much wider applicability if there were more teachers and subject advisers included. Further research needs to be done whereby the sample will include the whole province and all districts included. This might improve the applicability and generalizability of the findings from this study.

4.10 Summary

This chapter was mainly outlining research methodology and procedures with special focus on the instruments used to collect data. The next chapter will be on data presentation, discussion, interpretation and analysis.

CHAPTER 5: DATA PRESENTATION, DISCUSSION, INTERPRETATION AND ANALYSIS

5.1 Introduction

This chapter presents the data, discusses and interprets the findings. This data was collected using questionnaires, interviews, lesson observations and document analysis to unpack the challenges teachers encounter in teaching Number Patterns in secondary school level when transiting from primary to secondary level. The process of data collection started with the questionnaires given to teachers, followed by lesson observations then interviews done at the same time as document analysis. Each participant from the seven schools selected participated in answering the questionnaire. One teacher in a primary school and three in three secondary schools from the sample of seven selected participants, participated in interviews and provided information for the document analysis.

Participants' responses were used to answer the following research questions: The first question is what challenges do mathematics teachers have in using number pattern concepts from primary school at secondary school level? The second question is how do teachers use their knowledge of number pattern concepts from primary school at secondary school level to overcome challenges? The third question is how do these challenges affect teaching of number pattern concepts at secondary school level using their primary school knowledge? It was also aimed at how teachers use their knowledge of Number Pattern concepts from the primary school level transitioning to the secondary school level to overcome challenges. The first discussion was on data presented from the participants' responses.

5.2 Data Presentation

All research needs data presentation and analysis (Ningi, 2022) and information collected to arrive at the findings. According to Rijali (2019), data collection is also part of data analysis activities. The researcher presented, analysed and interpreted the collected data in terms of the objectives of the research study by isolating similarities and differences. The study was to explore challenges teachers have in the teaching of Number Patterns as learners' transit from

lower to higher levels. The deductive analysis approach was adopted for data analysis in this research which starts from the theory and the concepts emerge.

The process of the data presentation or analysis begins with a step-by-step guide as a way of identifying, interpreting, and creating themes within the set of data (Ningi, 2022). It follows a pattern of moving from data generation to data display, reduction, meaning-making, data presentation/analysis and then conclusion. The data generation began by discussing the profile of teachers and their participating schools.

5.2.1 Profile of the Participating Teachers and their Schools

This section presents the demographic data of participants and their participating schools. There were seven participating teachers who teach mathematics either in the GET or FET or in both phases. All the participating teachers have taught for more than 3 years. The participating teachers' age ranges from 20 to 60 years. All participants responded to the challenges they have when learners transit from lower classes in Number Patterns in their respective schools and classrooms. Seven teachers from three primary and four from four secondary schools participated in the study and responded to the questionnaires provided. Four teachers were interviewed and observed teaching for this study, one from the primary school and three from secondary schools.

In Amajuba district there are only two circuits which is why schools were directly selected from those two circuits. Two primary schools starting from grade one up to grade seven while one is starting from grade R up to seven, but research was only focusing on grade 7 classes. All secondary schools start from grade eight to twelve. Some schools have more than one teacher teaching mathematics but only one experienced teacher was selected to participate in this study in each school as explained previously. Figure 5.1 displays participants' profiles including number of learners they are teaching and number of mathematics teachers in their respective schools.

Figure 5.1 provides information about the number of learners and teachers in each school that participated in the study. Queen Primary school has the largest number of teachers teaching in grade 7. Ntuthuko primary school has the lowest number of learners in grade 7. KwaMdakane

and Phumzile secondary schools show a great decline in terms of numbers of learners continuing with mathematics. Jojo (2019) argued that more learners avoid mathematics and opt for mathematical literacy when they exit GET level and enter FET. That is why in the graph it is noticeable that there is a large decline in mathematics in two schools. The other two schools have opposite statistics because of their admission policies that make them admit new learners from outside the school in the FET phase. Phumzile and Sthembiso secondary schools have only one teacher each teaching from grade 8 to 12. The teachers from the two schools are overstretched as the ratio of teacher-learner is above the accepted level. Learner-teacher ratio is a very important aspect that needs to be considered by most schools (Sutcher, Darling-Hammond and Carver-Thomas, 2019). Overcrowded classes are one of the challenges teachers have when teaching mathematics including Number Patterns as learners' transit towards higher classes.

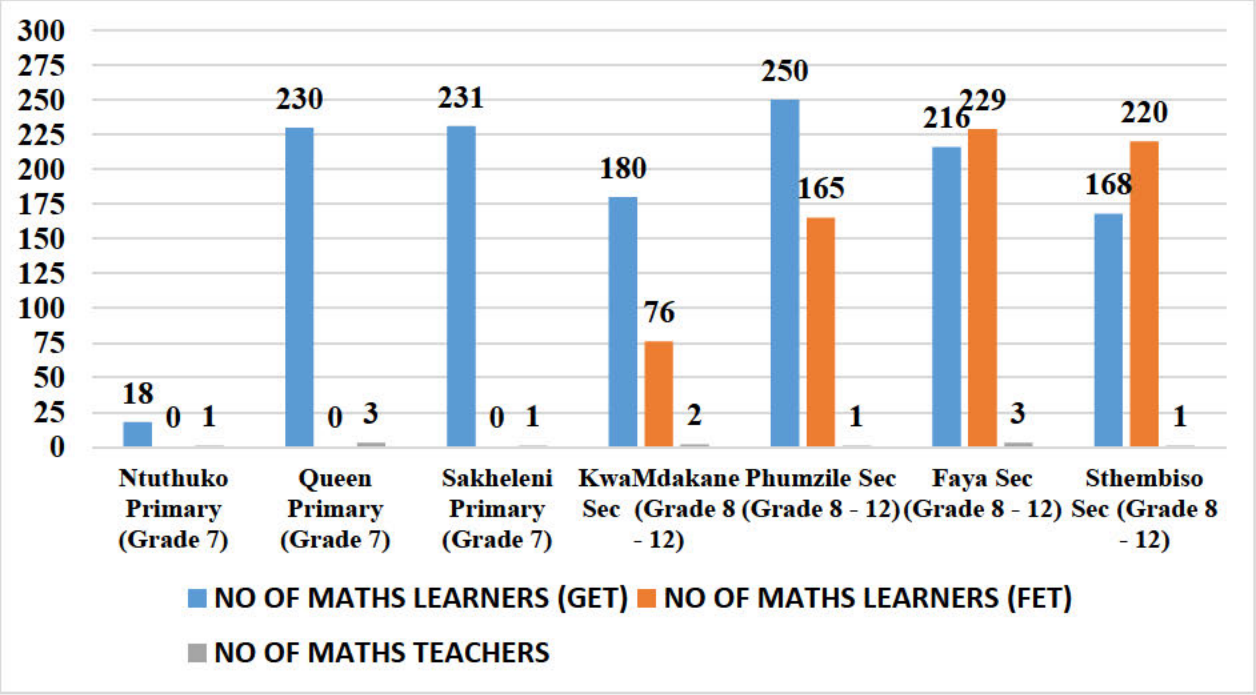


Figure 5.1 Number of learners and teachers in each school (Own)

Table 5.1 shows that there were 3 primary and 4 secondary teachers who participated in the study. Teachers participating in the research were given pseudonyms and codes. This table is just for the participants and their schools who all participated in filling in the questionnaires.

Table 5.1: Participants and schools' information for all participants (Own)

Pseudonyms	Code	School
Ntuthuko primary School Teacher - Vuyiswa	P1	1st Primary school in Amajuba District
Queen primary School Teacher – Zakes	P2	2nd Primary school in Amajuba District
Sakheleni primary School Teacher - Thobs	P3	3rd Primary School in Amajuba District
KwaMdakane secondary School Teacher - Phungula	S1	1st Secondary school in Amajuba District
Phumzile secondary School Teacher - Phindile	S2	2nd Secondary school in Amajuba District
Faya secondary School Teacher – Mlilo	S3	3rd Secondary school in Amajuba District
Sthembiso secondary School Teacher - Bhagwana	S4	4th Secondary school in Amajuba District

Different participants were summarised as follows:

(a) Vuyiswa

Vuyiswa is a female teacher teaching mathematics at Ntuthuko Primary School in the Amajuba district. She is the only mathematics teacher in the Intermediate and Senior phases, hence teaching grade 4 to 6 learners. She teaches in the GET phase and is comfortable teaching GET mathematics. Based on the responses to the questionnaire, Vuyiswa's learners do not participate in Olympiads, additionally, she has indicated that she requires further development in the teaching of Number Patterns more specifically the teaching of arithmetic sequences.

(b) Zakes

Zakes is a teacher teaching mathematics at Queen Primary School in the Amajuba district north of KZN. He is one of the 3 teachers teaching the Intermediate and Senior phases. He is the teacher for grade 6 and 7 learners. He is a male teacher between the age of 20 and 30 and has 4

years of experience teaching grades 4 to 7 in the primary phase. He is currently teaching Number Patterns in grades 4, 5, 6, and 7. He is specializing in isiZulu, mathematics, and NSTECH. His highest qualification is a BEd specializing in the intermediate and senior phases. His school is participating in problem-solving Olympiads.

(c) Thobs

Thobs is a teacher teaching mathematics at Sakheleni Primary School in the Amajuba district North of KZN. He is the only mathematics teacher teaching in the Intermediate and Senior phases, hence teaching grade 4 to 6 learners. Thobs is a male teacher from the one of the primary schools involved in the research. He has 18 years of experience teaching grades 4 -7 which he is still currently teaching. His age group is between 51 and 65. This primary school does not participate in problem solving.

(d) Phungula

Phungula is a male teacher teaching mathematics at KwaMdakane Secondary School in the Amajuba district North of KZN. There are two mathematics teachers in the school, one teaching in GET, and Phungula is responsible for the FET phase. Phungula filled out the questionnaire and was also interviewed. He is currently teaching grades 8 to 12 with the experience of 16 years teaching mathematics. He is between the age of 31 and 40 and has NPDE as the highest qualification. The previous years' results do not reflect that the school is participating in problem-solving Olympiads. The schools participating in Olympiads always produce good mathematics results. Matric results in this school have never been above 40% which is a disaster. It is noticeable that learners are also not doing well in Number Patterns.

(e) Phindile

Phindile is a female mathematics teacher in the Amajuba district situated in the North of KZN. Phindile is teaching mathematics in both the GET and FET phases at Phumzile Secondary School. She is the only mathematics teacher in the school hence teaching from grades 8 to 12. She is between the age of 31 to 40 with STD and ACE as her highest qualifications. She has been teaching mathematics for 9 years in both the GET and FET phases. She is teaching 250 learners in GET and 165 in FET and is the only mathematics teacher in the school. In this school

grade 9 is performing very well more than all other grades in the school. The worst performers are in grades 11 and 12.

(f) Mlilo

Mlilo is a male teacher teaching mathematics from grades 8, 9, and 10 at KwaMdakane Secondary School in the Amajuba district North of KZN. There are three mathematics teachers in this school. Mlilo has 3 years of experience in teaching mathematics at GET and FET phases and teaches more than 400 learners. He is between 31 and 40 years of age. Unfortunately, his school is not participating in problem-solving Olympiads which is one of the major setbacks in terms of excelling in mathematics skills and getting good results. Learners that are exposed to problem-solving think critically and enhance design thinking.

(g) Bhagwana

Bhagwana, a male teacher teaching mathematics from grades 8 to 12 at Sthembiso Secondary School in the Amajuba district participated in the study. He is the only mathematics teacher in the school teaching from grades 8 to 12. This means that he oversees both FET and GET phases of which he has 6 years' experience. He is between the age of 31 and 40 of age and his highest qualification is PGCE. The school is not participating in problem-solving Olympiads which is the cause of poor performance in matric results.

In Table 5.2 participants are listed with their pseudonyms and descriptions and shows teachers who were randomly selected to participate in the lesson observations. Four out of the seven participating teachers were randomly selected considering their experiences in teaching the subject.

Table 5.2: Codes, Pseudonyms and description of participants selected for lesson observations (Own)

Code	**Pseudonyms**	**Teachers' description**
Teacher Ntuthuko Prim	Vuyiswa	The first observed teacher in primary School A
Teacher KwaMdakane sec	Phungula	The second, observed teacher in secondary School A
Teacher Phumzile sec	Phindile	The third observed teacher in secondary School B
Teacher Faya	Mlilo	The fourth observed teacher in secondary School C

Table 5.3 shows that all the participating teachers have taught for more than 3 years. All primary school teachers who participated have 4 years or above in experience of teaching mathematics, which shows that there is no newly appointed teacher among them. The average teaching experience in the GET phase is 8 years and 6 years in FET. The participating teachers' age ranges from 20 to 60 years. Most of the participants are between the age of 31 and 40. The minimum teaching experience of the participants in the secondary school is 3 years, and the maximum is 16. Table 5.3 shows the names of the teachers who participated in the research. Names used are pseudonyms. Five male and two female teachers completed the questionnaires because there are more male teachers teaching mathematics in higher grades starting from grade 7 going up to grade 12 (Leyva, 2017).

The lowest qualification of participants is Primary Teachers Diploma (PTD) and the highest was a Bachelor of Education (BEd). The minimum qualification for any teacher in South Africa is M+3 which means matric and three years of training to be a teacher. According to the information reflected in table 8 it is evident that all teachers that were involved in this study were well qualified with more than the minimum requirement for a South African teacher except one teacher with PTD which is the M+3 qualification. This was in support of Jojo (2019) who argued that teachers must be trained properly in all aspects and skills that will be required when they are teaching in their classrooms. However, from this study some teachers e.g., those with PGCE seem not to be trained

in all aspects where mathematics teaching is concerned. Moreover, Buthelezi (2016) emphasised South African teachers have a minimum of three-year qualification when they are expected to have a master's degree and above. Looking at the qualification and experience of the teachers, it was concluded that they all had a minimum required knowledge and expertise to teach the subject.

Table 5.3 Age group, teacher qualifications, and experiences in teaching mathematics (Own)

NAME (PSEUDONYM)	TITLE	GENDER M/F	AGE GROUP	HIGHEST QUALIFICATION	SUBJECT AND GRADE TEACHING	NUMBER OF YEARS TEACHING MATHEMATICS	
						GET	FET
VUYISWA	Miss	F	31 - 40	PGCE	Mathematics Gr 4 -7	6yrs	N/A
ZAKES	Mr	M	20 - 30	PGCE	Mathematics Gr 4 -7	4yrs	N/A
THOBS	Mr	M	51 - 60	PTD	Mathematics Gr 4 -7	18yrs	N/A
PHUNGULA	Mr	M	41 - 50	NPDE	Mathematics Gr 8 -12	16yrs	N/A
PHINDILE	Miss	F	31 - 40	ACE	Mathematics Gr 9 -12	9yrs	9yrs
MLILO	Mr	M	31 - 40	Bed	Mathematics Gr 8 -10	3yrs	3yrs
BHAGWANA	Mr	M	31 - 40	PGCE	Mathematics Gr 10 -12	6yrs	6yrs

5.2.2 Presentation of data from Questionnaires

Three research questions were partly answered in the questionnaire which were as follows: The first question is what challenges do mathematics teachers have in using number pattern concepts from primary school at secondary school level? The second question is how do teachers use their knowledge of number pattern concepts from primary school at secondary school level to overcome challenges? The third question is how do these challenges affect teaching of number pattern concepts at secondary school level using their primary school knowledge? Information gathered from the questionnaire was discussed in Table 5.4. This section discusses participants' participation in Olympiads, their use of problem solving, their teaching of Number Patterns and their transition from lower to higher classes.

Table 5.4 Information about participants, their schools, and problematic topics (Own)

	VUYISWA(P1)	ZAKES	THOBS	PHUNGULA	PHINDILE	MLILO	BHAGWANA
Participation in Olympiads	No	Yes	No	Yes	No	No	No
Phase Teaching Number Patterns	GET	GET	GET	FET	GET & FET	GET & FET	GET & FET
Learners' previous knowledge of Number Patterns	Yes	Yes	No	Yes	Yes	Yes	No
Moving with learners to the next grade	Yes	No	Yes	Yes	Yes	No	Yes
Phase comfortable teaching	GET	GET	GET	FET	GET & FET	GET & FET	GET & FET
Need development in teaching Number Patterns	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Topic/subtopic for development	Arithmetic sequences	Identifying rule or pattern	Extending Number Patterns	Derivation of the formulas	Real-life applications	Sigma Notation	Problems involving simultaneous equations

From Table 5.4, it was noticeable that most schools that participated in the questionnaires were not taking part in the Olympiads as only Zakes and Phungula out of the seven schools took part in them. The lack of schools' participation in Olympiads shows that schools are not using problem solving when teaching their learners. Shoba (2020) emphasised that the DBE was willing to adopt and use problem solving after ANA results. This shows clearly that participating schools were not adopting the use of problem-solving in their teaching and learning of mathematics which may result in the underperformance in the NSC results. Most participating schools showed that their learners do have knowledge of previous knowledge of Number Patterns. Only two out of the seven complained of lack of previous knowledge in Number Patterns.

Knowledge of different strategies could assist teachers in their teaching of Number Patterns as learners' transit from lower to higher grades in their classrooms (Lamon, 2020). Therefore, this showed that the learners should be able to transit with knowledge of Number Patterns from lower to a higher grade. Hiebert and Stigler (2023) advise that the main reasons why learners are still struggling with mathematics is lack of knowledge of Number Patterns. Lithner (2015) remarked

that many teachers are still doing rote learning and making their learners rote thinkers. All teachers participated in this study highlighted that they need development in Number Patterns. They further mentioned specific topics they have challenges to teach or present to their learners. The researcher consulted subject specialists and schools' Departmental Heads (DH) to address various challenges teachers highlighted when answering the questionnaires and during interviews.

Therefore, this made the researcher wonder if the transition of teaching Number Patterns from lower to higher classes was not based on rote learning but rather utilising the four main strategies to solve Number Patterns problems. The four Number Patterns strategies according to Lamon (2020) are direct counting, direct proportion, recursive strategy, and mental image representation. These strategies need to be communicated and encouraged to all teachers to address challenges teachers have when teaching Number Patterns as learners' transit to higher grades.

5.2.3 Presentation of Data from Interviews

Table 5.5 is only displaying participants that were selected to take part in the interview processes as not all seven participants were involved in interviews. One from the primary school and three from the secondary schools participated in interviews. They were all the same race and two were males and the other two were females. Gender was well balanced since Leder (2019) was unhappy with gender imbalance in mathematics teachers teaching at the secondary school levels. The two females selected for the interview process composed of a female teacher from the primary school and the other from the secondary school. It was semi-structured interviews and was recorded and transcribed from the beginning to the end.

Table 5.5: Profile of participants for interviews (Own

Code/Pseudonyms		**Schools Descriptions**	**Race**	**Gender**	**Grade(s) Teaching**
School	**Teacher**				
Ntuthuko Primary School	Vuyiswa (PSA1)	1st Primary school in Amajuba District	African	F	4 – 7
KwaMdakane Secondary School	Phungula (SSA1)	1st Secondary school in Amajuba District	African	M	8 – 12
Phumzile Secondary School	Phindile (SSD2)	2nd Secondary school in Amajuba District	African	F	8 – 12
Faya Secondary School	Mlilo (SSC3)	3rd Secondary school in Amajuba District	African	M	8 -10

Table 5.5 shows the profiles of schools and teachers who participated in the interviews and their respective codes. The interview opportunity allows the participants to express their perceptions, feelings and understanding of the situation (Pessoa, Harper, Santos & Gracino, 2019). Therefore, teachers were given the opportunity to voice their challenges when teaching Number Patterns as their learners' transit to higher levels. The four teachers appearing in Table 5.5 were interviewed using the questions prepared in the interview template. Three secondary school teachers and one primary school teacher were selected for the individual interviews based on how they responded to the questionnaire. The questionnaires illustrated that learners have previous knowledge, but they cannot link it with the new knowledge.

The teachers selected for the interviews were given different code: PSA1, for teacher number 1 from primary school 1, SSA1 for teacher number 1 from secondary school 1, SSD2 for teacher number 2 from secondary school 2, and SSC3 for teacher number 3 from secondary school 3. The number given to the teachers was not significant but just a way of identifying the teacher from other participants in the same district. When the 4 interviews were recorded, the teachers were referred to by their pseudonyms namely Vuyiswa a Primary School Teacher 1, Phungula a Secondary School Teacher 1, Phindile a Secondary School Teacher 2, and Mlilo a Secondary School Teacher 3.

5.2.4 Presentation of Data from Lesson Observations

The same participants that were involved in interviews participated in lesson observations. The researcher made an appointment with the teacher involved and visited him/her in class when a Number Pattern lesson was being taught. Teachers do not like to be visited in class while teaching as they feel that the visitors are there to criticise. Most of the teachers visited were not comfortable during the process as the visitor was also their subject advisor. The researcher had to assure them that the visit is for the matter of research only and nothing else. The researcher gave them more assurance that information will not even be given to their departmental heads or principal. Lessons were well presented, and teachers were well prepared. The only thing the researcher noticed was that the teaching is more teacher-centered than learner-centered. Their content knowledge is very good but they have to change their approaches in their teaching.

5.2.5 Presentation of Data from the Document Analysis

The results of the same teachers' schools for the past 5 years were analysed as the researcher wanted to have analyses per topic which was not available in all four schools involved in this exercise. The researcher used mathematics as a whole result. In one school the researcher could not get results for the past 5 years but only for the past three years as they do not have accurate records. This 5-year results analysis showed that the schools are underperforming and learners are not doing well as they transit from lower to higher levels which gives teachers challenges. The graph shows that performance reduces as learners move to upper levels.

5.3 Data Discussion and Analysis

The collected data was discussed based on the research questions and information collected from participants using questionnaires, interviews, lesson observations and document analysis. Research questions were designed to answer challenges teachers have when teaching their learners transiting from lower to higher classes. Table 5.6 gives us the research questions and the instruments used collecting data to be used in the study.

Table 5.6: Research Questions and Data Generation Methods and Anticipated approach (Own)

Research questions	Data generation Tools	Sampling process and participants	Anticipated approach
What challenges do mathematics teachers have in using Number Pattern concepts from the primary school level transitioning to the secondary school level?	Questionnaire Observation and Interview	**Questionnaire** – Three teachers from three primary schools and four teachers from four secondary schools filled the questionnaire. **Observation** – one teacher in one primary and two teachers in two secondary schools were observed in class. **Interview** – one teacher in one primary and three teachers in three secondary schools participated in the interview.	Deductive approach
How do teachers use their knowledge of Number Pattern concepts from the primary school level transitioning to the secondary school level to overcome challenges?	Questionnaire Observation and Interview	**Questionnaire** – three teachers from three primary schools and four from four secondary schools participated. **Observation** – one teacher in one primary and two teachers in two secondary schools participated. **Interview** – one teacher in one primary and three teachers in three secondary schools participated.	Deductive approach
How do these challenges in Number Pattern concepts at the primary school level affect teaching transitioning to the secondary school level?	Interview and Document Analysis	**Interview** – one teacher in one primary and three teachers in three secondary schools participated in the interview. **Document analysis** for the past results in Number Pattern (referring to schools' past years' schedule and DOE grade 12 Diagnostic analysis) – one teacher in one primary and three teachers in three secondary schools were selected for an interview and must provide analysis for their schools.	Deductive approach

5.3.1 Challenges in Teaching Number Patterns in Higher Classes

Challenges mathematics teachers have in using Number Pattern concepts from primary school at the secondary school level were answered by the first question which was: *What challenges do mathematics teachers have in using number pattern concepts from primary school at secondary school level?*

This question was answered through questionnaires, and interviews. Seven teachers participated in filling in the questionnaires i.e., three primary and four secondary school teachers. One teacher from the primary and three from the secondary schools were interviewed. Two teachers from the secondary and one from the primary were observed teaching Number Patterns in their respective classes. No real names were used for each individual school and teacher.

Vuyiswa, a teacher from primary school 1 (PSA1) in the Amajuba district north of KZN participated in completing the questionnaire. She is a young female between the age of 31 and 40. Her highest qualification is PGCE and has been teaching grades 4 to 7 for 6 years. In this school, problem-solving is not used at all in teaching and learning of mathematics. They do not participate in solving problem-solving competitions like the Olympiads. Topics like algebra, Number Pattern, functions, measurement, applications, modelling, and logic are mostly used in Olympiads' tests (Engelbrecht & Mwambakana, 2016). Therefore, it can be affirmed that engaging in problem-solving can make learners gain many Number Patterns concepts. Using problem-solving in school makes learners become confident in solving mathematics problems. Problem-solving will help learners understand Number Patterns and many other topics in mathematics reducing challenges teachers may encounter in teaching and learning of mathematics. This implies that teachers must reinforce the participation of their schools in problem-solving Olympiads.

Failing to participate in problem-solving, produces learners that lack the mathematical skills of solving any problem in mathematics. According to Vuyiswa's response regarding previous knowledge of Number Patterns, her learners do not know what they have learnt in previous grades and cannot integrate or use that knowledge in the present situation. As the teachers in this school move with their learners from one level to another it is important that they know exactly what they taught them in the previous grades so that learners cannot lie and say they

were not taught in the previous classes. Moving with your learner is of great advantage to the teacher as he/she knows exactly what gaps need to be filled from the previous grade. That will lessen the challenges teachers have when teaching Number Patterns in the current grade.

Vuyiswa mentioned that there is not much of a problem in grade 5 but starts when they are in grades 6 and 7. Grade 4 is also not performing well in Number Patterns and mathematics. This may be caused by language switching as they begin to switch the language of instruction from vernacular to second additional. The most important challenge teachers have in mathematics teaching and learning is that they do not complete the Annual Teaching Plan (ATP). The ATP starts to increase the workload in grade 6 while learners are very slow to understand. Number Patterns is one with packed topics which need enough time to unpack and teach properly. Looking at the overall performance in mathematics grade 7 in 2019 which was 38% and 57% in 2020, we can agree that this is unacceptable for these young children. There is a great underperformance noticed in this school for grade 7.

Another participant was Zakes, a teacher from the second primary school (PSB2) who is a male teacher between the age of 20 and 30 and has 4 years of experience teaching grades 4 to 7 in the primary phase in the Amajuba district north of KZN. He is specializing in isiZulu, Mathematics, and NSTECH. His highest qualification is a BEd specializing in the intermediate and senior phases. His school is participating in problem-solving Olympiads. He is currently teaching Number Patterns in grades 4, 5, 6, and 7. Learners cannot lie that they were not taught as the same teacher stays with them in grade 7. According to the subject teacher, learners just lack using the skills they were taught in the previous grades and do not fuse them with the new subject matter of the same topic. Teachers only need to drive their learners in their teachings towards understanding that whatever was taught to them in previous grades is just the foundation laid for what they will learn in the upper grades going forward. Overall performance in mathematics for PSB2 school increased from 52% in 2019 to 68% in 2020. It can be observed that before 2019 the overall pass percentage in this school for mathematics was below 50%.

Thobs is a teacher from the third primary school (PSC3) who is an experienced male teacher with 18 years teaching experience and currently teaching grades 4 to 7 mathematics in the primary school in the Amajuba district north of KZN. His age group is between 51 and 65 and

his highest qualification is Primary Teachers Diploma (PTD). PSC3 primary school does not participate in problem solving hence they do not enter Olympiad competitions. Learners from this school do not have enough knowledge from previous classes and are very weak in Number Patterns. One of the good practices is that teachers move with their learners. Only one teacher is available to teach from grade 4 to 7 and there is no other mathematics teacher in the school. An increase of 3% from 2019 overall performance was observed as the PSC3 school got 49% in 2019 and improved to 52% in 2020. In 2018 it was the worst performance as the school performed overall at 25% which was a disaster. Though the teacher cannot provide us with Number Patterns' performance, it is evident that learners performed very badly in all topics including Number Patterns during this year. The teacher must make sure that a thorough revision of the previous work is done and infused with the new content.

Another participant, Phungula a male mathematics teacher from the first secondary school (SSA1) in the Amajuba district North of KZN was also interviewed. He is currently teaching grades 8 to 12 with the experience of 16 years teaching mathematics. He is between the age of 31 and 40 and has NPDE as the highest qualification. The previous years' results do not reflect that the school is participating in problem-solving Olympiads. Matric results in this school have never been above 40% which is a disaster. It is noticeable that learners are also not doing well in Number Patterns. Phungula is teaching mathematics including Number Patterns in grade 10, 11, and 12 classes and another teacher teaches grades 8 and 9. Looking at the overall performance in grades 8 and 9 you can notice that they are the worst-performing grades in the school. Grade 10 – 12 performance is affected by what is happening in grades 8 and 9. Teachers in grades 8 and 9 are not doing justice in teaching mathematics.

When interviewed the teacher mentioned that learners start to have a little knowledge of Number Patterns at the FET level. Learners in grades 8 and 9 have little or no knowledge of Number Patterns. Rotation of teachers occurs around the phase i.e., one teacher takes learners from grade 8 and hands them over after grade 9 to another teacher who will take them from grade 10 to the exit point, grade 12. Phungula is comfortable teaching in both the GET and FET phases.

Phindile is a female mathematics teacher in the Amajuba district situated in the North of KZN. She is between the age of 31 to 40 with STD and ACE as her highest qualifications and has been teaching mathematics for 9 years in both the GET and FET phases. She is teaching 250 learners in GET and 165 in FET and is the only mathematics teacher in the school. In this school grade 9 is performing better than all other grades in the school. The worst performers are in grades 11 and 12. The school is not participating in problem-solving activities. This may affect mathematics skills that have to be gained by learners when involved in problem-solving. The English Across the Curriculum (EAC) is also not helping the school as the teacher in her interview complained that her learners cannot understand English which makes it more difficult for them to understand the mathematics language.

Mathematics is a language on its own inside the English language. It shows that the principal and his SMT must work on language issues in the school. The school must ensure that there is an existing structure that focuses on the implementation of EAC whereby English and content teachers unite and reinforce English across all subjects taught in the school (Yurekli et al., 2020). The environment and being second language speakers are the factor that affect learners' understanding and performance to the required standard in mathematics and Number Patterns as such. First-language speakers always do better than second-language speakers in mathematics. There is a lot of disconnection when linking the GET and FET mathematics which is mainly caused by this EAC mentioned above.

Mlilo, a teacher from the third secondary (SSC3), is a male mathematics teacher in the secondary school in Amajuba District North of KZN. He is currently teaching grades 8, 9, and 10 and has 3 years of experience in teaching mathematics at GET and FET phases. He is a teacher of more than 400 learners and is between 31 and 40 years old. Unfortunately, his school is not participating in problem-solving Olympiads which is one of the major setbacks in terms of excelling in mathematics skills. Learners exposed to problem-solving think critically and enhance design thinking. Learners must acquire problem-solving skills to excel in any mathematics content including Number Patterns. Mlilo is teaching in both GET and FET and knows what happens in transitioning learners from primary school to GET and later to FET. He cited that challenges in Number Patterns are more in grades 8 and 9 and gradually reduced as they enter the FET phase in grade 10. It can be that in grades 8 and 9 mathematics teachers are

doing damage control that emanates from the senior and intermediate phases. The foundation phase learners are taught mathematics in their mother tongue and assessed continuously which makes it difficult to compare it with other phases.

According to Mlilo, there is disconnection in linking the GET and FET Number Patterns. In the interview this teacher highlighted that learners in grades 8 and 9 have the attitude of looking at mathematics as a great monster. This attitude pervades most learners in the FET phase and is the major challenge in mathematics teaching and learning including Number Patterns. The interview also reflected that it is not that learners are blank and do not have knowledge of mathematics Number Patterns, but they need to integrate the previous knowledge with the new content and never look at them as different entities. Overall achievement in mathematics reflects that in this school grades 8 and 9 are performing poorly with an average of below 40%, and gradually improving from grade 10 to grade 12.

Bhagwana is a male teacher teaching grades 8 to 12 at the fourth secondary school (SSD4) in Amajuba District North of KZN. This means that he oversees both the FET and GET phases. He has 6 years of experience teaching in both GET and FET phases, is between the age of 31 and 40 and has a PGCE as his highest qualification. The school is not participating in problem-solving Olympiads which is the cause of poor performance in matric results. The matric results for this school are always below 50% up until 2020 when they were at 53% in which is an improvement of 2% from 51% achieved in 2019. The teacher feels the learners do not have enough previous knowledge of Number Patterns. He is blaming primary teachers for not doing their work or not correctly teaching mathematics. He is the only teacher in the school teaching mathematics. Although he was not participating in the interviews he mentioned that the learners entering the FET phase through grades 8 and 9 lack mathematics skills from their primary schools. As he is teaching Number Patterns in both GET and FET phases he prefers to teach FET than GET. He experiences more challenges when teaching Number Patterns in grades 8 and 9 which falls under the GET phase and enjoys Number Patterns in GET especially when there is using of formulae.

5.3.2 Teachers' Use of Knowledge About the Understanding of Number Pattern Concepts

The second question to be answered in this research is: *How do teachers use their knowledge of number pattern concepts from primary school at secondary school level to overcome challenges?*

This question was also answered through questionnaires, lesson observations, and interviews.

When teachers were engaging with the questionnaires, observations, and interviews it was noticed that none of them blamed themselves and continually blamed learners and/or teachers from previous grades. It is the norm that teachers always blame teachers from the previous classes when learners are underperforming. Almost all teachers interviewed from the FET phase blamed primary teachers when learners are underperforming. One teacher was asked in the interview if this problem is occurring in other subjects which does not seem to be the case. Good results are not occurring in all the schools that were participating. Learners are performing poorly in mathematics as well as Number Patterns itself. Teachers' qualifications are at the accepted standard and all have a minimum of 4 years of training in mathematics. It can be argued that it is not the qualifications of teachers that affects the teaching and learning of mathematics that leads to learners not doing well in Number Patterns. It is always said that teachers in primary schools sometimes teach subjects without knowledge because there are no teachers to teach those subjects, or they are not specializing but teaching all the subjects in their classrooms.

All teachers in the primary schools indicated that they need development and need to learn more about Number Patterns. It becomes difficult for this question to be answered as it is noticeable that teachers themselves need to be established and have confidence in the Number Patterns. All 3 teachers who participated in the survey in the primary schools need to be workshopped or retrained in the subject of mathematics and Number Patterns as such. The knowledge the primary teachers have on Number Patterns does not help the content problem learners have in Number Patterns. Development for these teachers can be done using content and methodology workshops. In arrears where they have started using Professional Learning Communities (PLC) that was introduced by the DBE in schools, they can use them to capacitate their teachers and improve their levels of competency. Advisors can also organize lesson demonstrations to empower and capacitate the teachers concerned. Teachers can also be developed by providing

them with video lessons to be used in and outside the classroom. Teachers can watch the video and use it as a teaching tool in his/her lesson.

With secondary school teachers, it is different although they all indicated that they need development, they have different reasons for it. One lacks problem-solving skills, another one is challenged by the topic and two need to learn more about the topic. It was discovered through this research that teachers do need problem-solving workshops and training to address the lack of problem-solving skills. The Association for Mathematics Education of South Africa (AMESA) is the None- Government Organisation (NGO) that schools need to associate with in order to acquaint their schools with problem-solving skills. The Association for Mathematics Education of South Africa (AMESA) is one of the structures that deals with problem-solving and Olympiads. Those teachers that indicated they lack problem-solving skills must be referred to AMESA for training.

5.3.3 Impact Caused by the Challenges on the Teaching and Learning of Number Patterns

The 3rd question was: *How do these challenges affect teaching of number pattern concepts at secondary school level using their primary school knowledge?*

This question was answered through interviews and document analysis.

Teachers having content knowledge gaps create many problems when teaching mathematics. They sometimes teach wrong concepts and learners incorporate wrong concepts and apply them to the new content which creates a lot of damage. As most of the teachers in primary and secondary schools mentioned they need to learn more about Number Patterns, implies that they had content gaps in their learning and training sessions which has continued to their current profession. If teachers are confident with their content knowledge, learners learn easily and grasp all the content knowledge delivered to them. A teacher from PSA1 cited in the interview that the problem of learners not understanding Number Patterns and other mathematics topics can be resolved when more time is given to a topic. The Annual Teaching Plan (ATP) is guiding every teacher to start and finish every topic at a particular time. Time needs to be well managed so that the teacher is on par with the ATP.

For the teacher to reclaim lost time he needs to organize extra classes which are outside the school's stipulated time. The disadvantage of these extra classes is that there are learners who will not be able to avail themselves after school hours for the lessons. It is now becoming a normal procedure in South Africa for schools, especially with matric learners to have afternoon, morning, Saturday, Sunday, and holiday classes. Some learners do not cope with these pressures enforced on them. The other way of catching up with time in the mathematics classroom is the use of technology which saves time other than writing and drawing diagrams on the board which is time consuming. Integration of knowledge and communication technologies (ICT) into the teaching and learning of mathematics in the classroom is of vital importance to save time in mathematics lessons (Das, 2019). Technology in mathematics teaching helps teachers to work smart and achieve their goals with ease.

Challenges teachers face when teaching Number Patterns at the FET level is that learners look blank and have no knowledge of any Number Patterns concept learnt in the lower classes. Number Patterns look like new thing they encounter in the FET phase according to their responses in the interview. Teachers at the higher levels struggle to cope with the ATPs as they spend most of their time teaching previous grades' content before zooming in on the new content. One of the teachers mentioned in the interview that he must return to grade 7 concepts when teaching his grade 11 classes. This causes many delays in such a way that he finds himself not catching up with scheduled times in the ATP. This teacher has no option but to use extra classes to catch up with the ATP.

Vuyiswa, a teacher from PSA1 school cited that she is having many problems when teaching grade 4 in her school. She mentioned that learners are taught mathematics in IsiZulu in grades 1 to 3 and must start learning mathematics in English in grade 4. It becomes so difficult for learners to switch the language to another completely different language. Learners fail to comprehend the challenging mathematical concepts presented to them in a language that is not their home language. This force grade 4 teachers to code-switch in order to make their learners understand. Code-switching makes teaching and learning slower and confuses learners more than helping them understand. Learners perform poorly in mathematics in grade 4, 5 and 6 because of this language switching and code-switching. It was a great mistake for those that approved the current curriculum to allow the Foundation phase to learn mathematics in IsiZulu

and sudden change in the Intermediate phase to switch to English. This changing of languages creates large gaps and makes learners look at mathematics as a very difficult subject.

Responses show that participants believed that using of problem-solving enhances learners' understanding mathematical content. Understanding of different mathematical contents including Number Patterns is of great value to overcome challenges teachers have in higher grades. Most of the teachers believed that bringing mathematical concepts to reality enhances understanding using problem-solving in every classroom situation. Schools that are involved in problem-solving find mathematics less complicated, hence Number Patterns will never be a problem to learners and they will understand the concepts of mathematics clearly. Teachers believed that problem-solving makes learners understand mathematics concepts. Teachers then have fewer or no challenges when teaching mathematics and Number Patterns. The research question is demanding answers of how do challenges in Number Patterns concepts affect teaching and learning of mathematics as learners' transit from primary to secondary school level. Challenges of not using problem-solving in the classrooms affect the performance of mathematics especially at grade 12 examinations. A teacher-centred instead of learner-centred approach is another challenge that affects teaching and learning of mathematics as well as Number Patterns.

Number Patterns are easily understandable when taught using real life problems. Participants believed that it greatly helped learners to relate mathematics to real life. Our daily life is always about mathematics and every living human being needs to use this mathematics daily. It becomes vital for every mathematics teacher to relate Number Patterns to real life which can make the learning of mathematics easier and simpler. Olympiads and other platforms of mathematics competitions bring a very important aspect of making learners take mathematics seriously. Mathematics results for the schools improves when problem-solving skills are used effectively. Number Patterns teaching and learning becomes easier when it is aligned to real life problems and infused with problem-solving skills. Lack of concordance between real-life problems and contextual problems in teaching and learning of mathematics cause differences in the mathematics concepts used (Magidi, 2015).

The Independent Examination Body (IEB) mathematics has developed highly competent learners that compete internationally. IEB is an independent agency which offers an alternative form of assessment, and is accredited by Umalusi which is the South African agency responsible for quality assurance in school examinations. IEB and the NSC are offering the intended curriculum in South African schools (Magidi, 2015). In South Africa, IBE's performance is very good because they use problem-solving in their schools. IEB is producing good matric results because of the engagement in the use of problem-solving in their classrooms. Using of problem-solving in the mathematics classroom helps in the performance of learners and the results improve drastically. Number Patterns no longer become problematic to both teachers and learners as they are problem-solving in their daily teaching and learning.

5.3.4 Using Constructivism Theory

Constructivism theory was selected to be used as the theory for this research. Constructivism emphasises the integration of the new knowledge with previously acquired knowledge for better understanding. Teachers will not experience challenges if learners understand and integrate existing knowledge of Number Patterns with the new knowledge. In the constructivism classroom, the teacher only assists learners to build their knowledge on the foundation of the previous knowledge. In a constructivism classroom, the focus shifts from teachers to learners and the teaching and learning becomes learner-centred instead of teacher-centred. The teachers' role is collaborative, embedded in cooperation, the pursuit of learners' interests and questions are encouraged, and primary sources of material and manipulative materials are examples of materials. Teachers engage in discussions with learners allowing them to build their knowledge.

Learners' work, observations, perspectives, as well as examinations, are all considered in the assessment process since learning is a collaborative process that builds on the learners' prior knowledge. In most activities, learners work in small groups and knowledge is observed as self-motivated, constantly changing with their encounters (Olusegun, 2015).

5.4 Data Interpretation

When data was analysed and interpreted it was discovered that one primary and one secondary are participating in the Olympiads. It was further discovered that through participation in

Olympiads, learners gain more knowledge of problem-solving. It is evident that one cause of the learners not doing well or teachers having challenges in Number Patterns and mathematics is a lack of problem-solving skills. Problem solving skills are very important aspects of teaching and learning mathematics that needs to be considered by every teacher when teaching Number Patterns and other topics in mathematics. Problem-solving skills must be mastered in every mathematics classroom to make the teaching and learning of any mathematics topic or concept easier. However, without problem-solving no effective mathematics teaching and learning can take place.

Using problem-solving make it easier for teachers to assist their learners in translating real life into mathematical problems. Real life mathematical problems can be simplified or translated through mathematics modelling. According to Bora and Ahmed (2019), modelling activities are very important in mathematics teaching with its different components and how they should be applied in mathematics teaching. Therefore, it is very important that all schools adopt problem-solving in their teaching of mathematics to change and overcome the challenges they encounter during the teaching and learning process of Number Patterns and other mathematics concepts. Problem-solving is part of the solution to make learners understand mathematical concepts. The practices of teaching mathematics require teachers to be well equipped with strategies of problem-solving.

Furthermore, one primary school and one secondary school have learners with little background in Number Patterns hence lacking previous knowledge of the topic. Primary teaching in mathematics lays the foundation of the subject in higher classes. A good foundation makes the work of the teacher easier whereas little, or no foundation creates challenges for the teacher concerned. Learners' difficulties with the understanding of the Number Patterns are pointed out as the symptoms of misunderstanding that is traced back to the methods of teaching and the lack of foundation by the learners from lower classes (Egodawatte & Stoilescu, 2015). These two schools mentioned above must research to find out where the problem emanated and how to go about solving it. Teachers in the higher classes always blame teachers from the lower grades and associate all misconceptions, gaps, and errors with them. However, teachers in higher classes find themselves in a very difficult situation of rebuilding the foundation and stretching themselves to reteach primary schools' mathematics.

According to Piaget, the new experience is integrated into an existing schema called assimilation (Bormanaki, 2017). This assimilation gives new ideas and knowledge and enables learners to match new ideas to those they already have. During assimilation learners are absorbing and fully understand everything they have learnt. It is evident that assimilation is not taking place in learners as they move from lower to higher levels. The use of technology in school activities speedily facilitates the assimilation of knowledge on the evaluation of mathematics content (Salas-Rueda, 2020). Learners are unable to match knowledge they already have in primary and senior phase grades with new knowledge they are learning in FET and matric. It is advantageous for teachers to move with their learners from one grade to another in a phase. This helps the teacher to address all the gaps and misconceptions that occurred in the previous grade. Information from questionnaires indicates that most schools are using the system of teachers moving with their learners across the phase except for one primary and one secondary.

In primary school whereby, the teacher is not moving with the learners because of big numbers which forces the school to have teachers teaching permanently in one grade i.e., we have one teacher for grade five, one for grade six, and one for grade seven. In one secondary school a teacher does not move with his learners because there is one teacher teaching grades eleven and twelve. The secondary teacher interviewed is always teaching grades eight and ten and receives new learners every year from other teachers. On the other hand, there is an advantage for the teacher not to move with his/her learners, for instance when the teacher is not communicating with the learners. Some teachers cannot teach mathematics properly because of different reasons resulting in an inferiority complex that goes to the extent that learners also have the same disability and never understand mathematics. They always underrate themselves and give up before they even start. Changing the faces of teachers sometimes helps some learners to do better and understand mathematics better than the previous grade.

Teachers in primary schools are comfortable teaching any class from grade 4 – 6 (Intermediate Phase) or Senior Phase (grade 7). Three out of four secondary schools' teachers are comfortable teaching mathematics in both GET (grades 8 & 9) and FET classes; and only one teacher in the secondary is only comfortable teaching in FET because he has been teaching grades 10 to 12 for a long time. There is a teacher specializing in grades 8 and 9 in this teacher's school. She is

permanently teaching GET mathematics and is refusing to move with her learners to the FET phase. In many schools, some teachers are not comfortable teaching beyond grade 9. Teachers from grades 8 and 9 like to stay there and never proceed to teach in FET (Umugiraneza et al., 2018) for different reasons. Some teachers do not have confidence teach up to grade 12, and others have no experience and are afraid to face new challenges.

There is much to be done in terms of developing teachers in Number Patterns and the whole of mathematics. All participants involved in this study are requesting development in the teaching of Number Patterns in their classrooms. Looking at the topics they identified as their arrears for development, it can be noticed that they have different topics. This shows that development in all Number Patterns topics must be done. Most of the teachers are good in content and lack methodology though there are still some that need to be trained in content.

According to Pournera et al. (2015), Teacher Content Knowledge (TCK) is very important to mathematics teaching and seems to be the basis for all teachers teaching mathematics. During the interviews, participants highlighted that there are still teachers that are not qualified enough to teach mathematics in the FET phase in their schools. In South Africa, the minimum qualification to be a teacher is matric plus 3 years of training (M+3). In other countries like some parts of India, the entrance qualifications for mathematics appointment as a teacher in their schools are pitched to a high level above 3 years diploma qualification (Aithal & Aithal, 2020). However, the minimum qualification in South Africa is a 3-year diploma (Jojo, 2019). Teachers' qualifications play a very important role in Teacher Content Knowledge. The more qualifications you have, the more content knowledge you gain. The systems of teaching and learning of mathematics demands highly qualified teachers.

These factors mentioned above have greatly contributed to how mathematics teaching within South African mathematics classrooms should be. In some primary schools, some teachers cannot teach mathematics in grade 7. This shows that the schools' systems of appointing mathematics teachers must recruit and appoint qualified competent mathematics educators in the primary and secondary schools. Subject advisors do workshops, but their focus is on newly introduced topics in the curriculum like Probabilities, Geometry, etc. They think Number

Patterns are an easy topic as it was there in the old curriculum and never check the analysis at the end of each year for NSC Mathematics examinations.

5.5 Summary

It was discovered through this research that the participants did teach Number Patterns and do have enough potential to make their learners understand the mathematical concepts of the topic, but learners are not achieving what is expected from them. Most teachers are trying their best to make their learners understand what they are teaching but very few learners capture and understand what was taught to them. It was also discovered through the study that there were only a few visual tools or teaching aids available to be used when teaching Number Patterns. The participants stated that it takes a lot of time using visual tools or teaching aids in the classroom and that it takes too much time to prepare teaching aids prior to the lesson. The next chapter discusses the findings, recommendations and conclusion of the research.

CHAPTER 6: DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

This chapter discusses the challenges as per the research question, using constructivism theory. According to the analysis done by the DBE after every session of the matric final examination, it was observed that teachers are not doing well in teaching mathematics concepts including Number Patterns and many challenges have been identified in schools that participated in this research.

6.2 Findings in Relation to the Research Questions

This study was able to answer all three research questions. As the participants responded to the questionnaires and interviews the research questions were addressed. They gave all challenges they are facing when teaching Number Patterns as their learners' transit from lower to higher levels. It was discovered that one of the causes for poor performance is that teachers are not using problem solving strategies as they teach in their respective classrooms.

The first research question was to identify challenges mathematics teachers have in using Number Pattern concepts from primary school at the secondary school level. However, the findings identified that teachers have challenges in terms of the content they are teaching their learners. The findings revealed that there are some mathematics teachers that lack content knowledge in teaching Number Patterns. The gaps in learners' content knowledge was also identified during interviews and questionnaire's responses. Most of the teachers in primary schools up to grade 9 do not finish the ATP as expected. They don't worry about finishing the ATP because at the end they only set papers of the work they have managed to teach.

The second research question was to determine how teachers use their understanding of Number Pattern concepts from primary school knowledge at secondary school teaching to overcome challenges. It was clearly discovered during interviews that teachers are trying their best to make sure that learners understand Number Patterns. Their concern was that there is no link or correlation between the primary and secondary school teachers. During interviews and questionnaires participants cited that there is no link between Senior Phase and FET. The two

bands are working in silos and blaming one another for the poor performance of learners in higher classes. Almost all schools that filled the questionnaires cited that they don't use problem solving and they are not involved in problem solving competitions and activities. During the interviews, participants saw the need of using problem solving in their classrooms to overcome Number Patterns challenges they encounter in their teaching and learning.

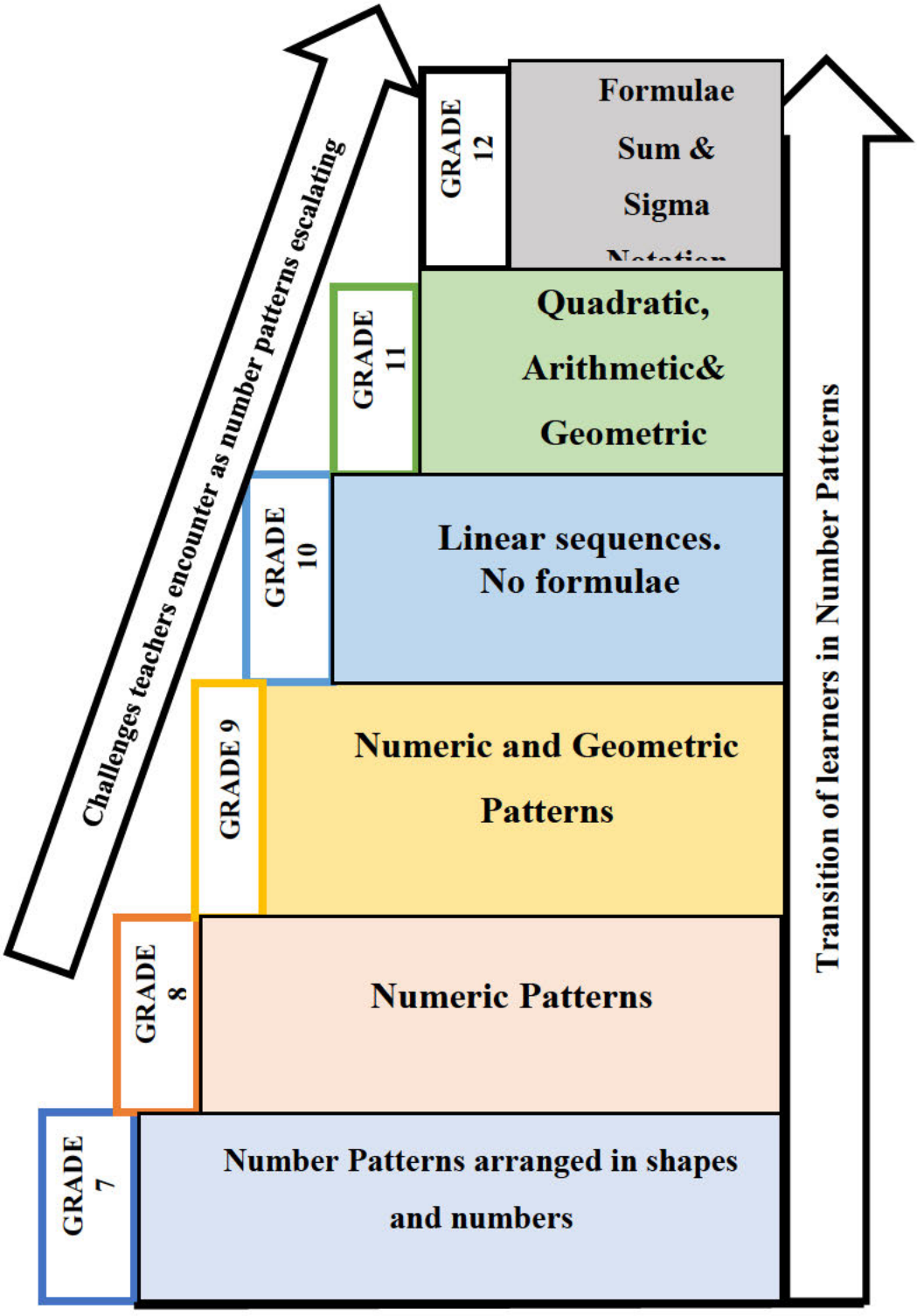
The third research question was to determine the extent to which challenges in using Number Pattern concepts from primary school at secondary school level, affect teaching. The challenges teachers are having when teaching Number Patterns especially in higher classes are having a great impact in the whole mathematics performance especially in matric results. It was discovered through this study discovered that teachers complain that many learners lack knowledge from previous grades, especially from primary schools. Research also discovered that in many schools there is an outcry that almost all secondary schools neglect grades 8 and 9 which affects teaching of Number Patterns in FET phases.

6.3 Findings in Relation to Relevant Literature

Many scholars complained about high failure rate of mathematics whereby Number Patterns also contribute towards this underperformance (Casinillo, 2019). Document analysis is the evidence to show that many schools are not doing well in mathematics. Teachers themselves confessed during the interviews supporting the literature by many scholars that there is a large problem with mathematics. The gaps created when learners are transiting to higher levels require attention for learners to do well in higher classes even matric.

6.3.1 Difficulty Levels as Learners' Transit from Lower to Higher Classes

Teachers always encounter challenges with Number Patterns as learners' transit from lower to higher classes. Figure 6.1 shows how Number Patterns topics get tougher as learners move up from grade 7 towards grade 12 classes. Teachers' challenges in teaching number problems also escalates as their learners do not cope with the content they are taught (Ojose, 2023).



Difficulty levels in Number Patterns

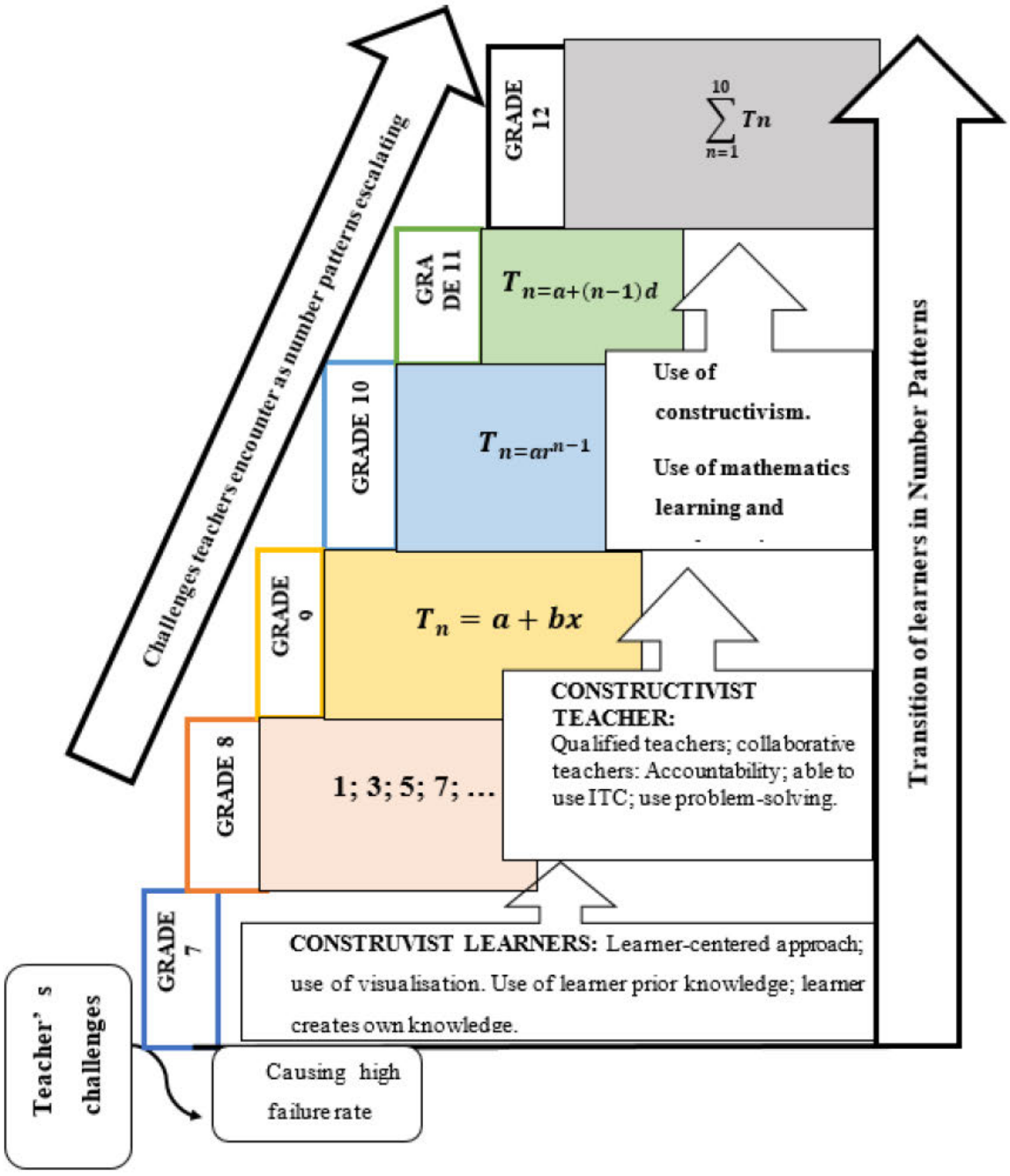
Figure 6.1 Difficulty levels in Number Patterns learning

6.4 Findings in Relation to Constructivism Theory

It was discovered through this study that constructivism theory is one of the theoretical framework teachers must understand and follow in their daily teaching and learning situations. It is emphasised in this theoretical framework that teaching needs to be more learner-centered than teacher-centered. It is again emphasised in constructivism that problem-solving needs to be used in teaching of mathematics. As learners learn mathematics they have to be encouraged to think critically by creating their own knowledge. Through constructivism learners are the centre of collaboration learning. Learners play a pivotal role in the teaching and learning environment. Therefore, this study recommended that teachers understand, adopt and use constructivism theory in their classrooms when teaching mathematics. If all schools can adopt problem-solving strategies, challenges that teachers have when teaching Number Patterns to their learners as they transit to higher levels from lower levels will be minimised.

6.4.1 Constructivism Theory and Number Pattern Difficulties

It was discovered that Number Patterns become more difficult as learners' transit from lower to higher classes and challenges of teachers escalate to the next level. Teachers must understand and use a learner-centered approach as it is recommended in constructivism theory. Figure 6.2 shows how constructivism is important in a mathematics classroom and teaching of Number Patterns.



Difficulty levels in Number Patterns Learning.

Figure 6.2 Constructivism and learning of Number Patterns (Own)

6.5 Findings in relation to the Methodology

All instruments were relevant to the study. Questionnaires showed that there is a large problem with mathematics. All teachers that participated in the completion of questionnaires cited that they need development in certain topics of Number Patterns which shows that there are some gaps that must be filled. Subject advisors and teacher development need to unite and create new ideas that will capacitate teachers and bring back confidence to their subject. The interview instrument was structured in such a way that it gives the performance in Number Patterns as responses and the causes of the poor performance including the solutions to overcome this underperformance. Document analysis responses showed that learners' performance declined as they move up to the higher classes. Findings related to methodology were further discussed based on deductive approach modelling.

6.5.1 Findings in relation to Methodology

The deductive approach model was mostly used during this study. As there were many challenges and a huge outcry about mathematics underperformance, this research was deemed essential. Participants gathered the data though questionnaires and other tools of data collection. Data was then analysed to elicit findings and recommendations. Figure 6.3 illustrates how the deductive approach works for this research.

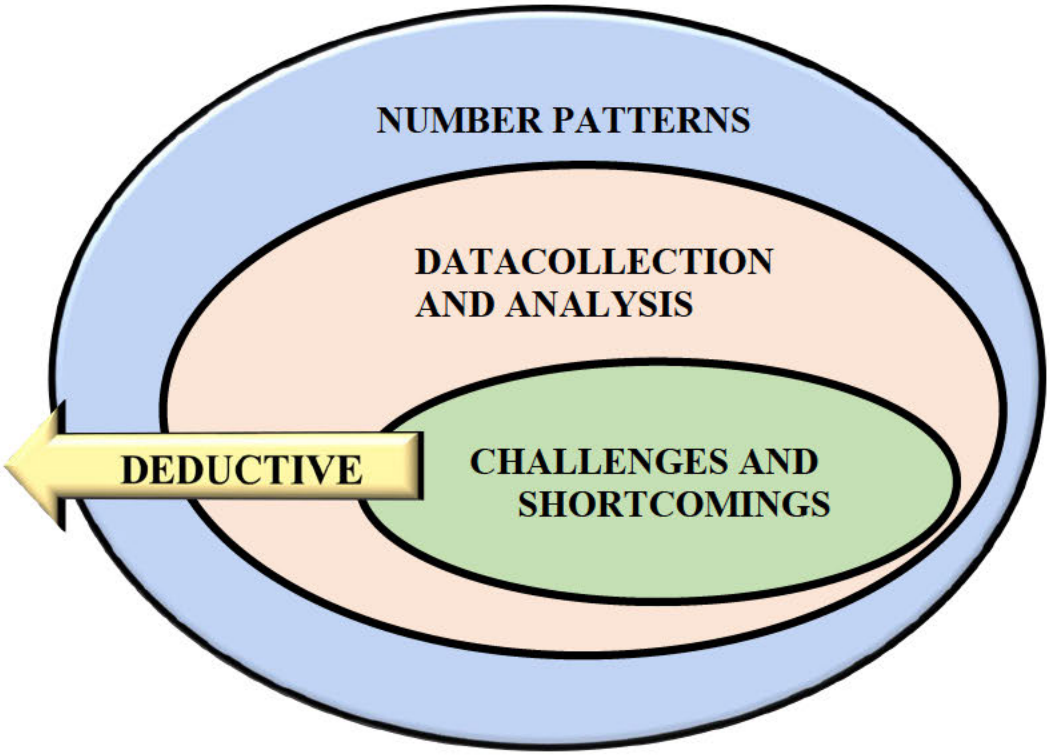


Figure 6.3 Deductive approach used in the study (Own)

6.6 Recommendations

Findings from the analysis of data lead to the general recommendations which might be helpful to address some of the issues raised and help deal with the challenges. Teachers must comply with the findings and recommendations suggested in order to address the issues raised and improve the teaching and learning of Number Patterns in their classrooms. The findings revealed that there are some mathematics teachers that lack content knowledge in teaching Number Patterns to their learners. However, workshops are not sufficient to capacitate teachers as the teachers need to be retrained in mathematics content including Number Patterns. The study also revealed that there is a huge gap between primary and secondary schools in terms of content knowledge for teachers. The findings also revealed that Number Patterns are not taught properly in primary schools hence learners lack Number Patterns background at the secondary level. However, the research recommends that most primary school teachers need to be trained thoroughly in Number Patterns or mathematics content. Considering my findings, I further

suggest that in-service or onsite training for all teachers in the system especially those from underperforming schools, must be provided.

The following challenges and recommendations are presented in the discussions that follows:

- **Use of problem-solving in the classroom** – All schools doing mathematics need to be encouraged to make problem-solving a priority in their schools. Problem-solving equips learners with sharp skills that are needed in the teaching and learning of mathematics. Schools must be encouraged to be part of problem-solving competitions like Olympiads and others. Number Patterns require many problem-solving skills hence they are inseparable. Most teachers lack knowledge of problem-solving, do not teach it nor encourage their schools to take part in any activity involving it. I recommend that the department train the mathematics teachers in problem-solving. I further recommend that it must be compulsory for all schools to be involved in problem-solving activities.

- **Language switching** – The study discovered that learners are not doing well in mathematics including Number Patterns. One reason for this poor performance is that in most schools learners start learning mathematics in Isizulu from grade R to grade 3. They start to switch to English in grade 4. Terminology is different hence learners experience new mathematics at the grade 4 level. This causes a three-year gap in proper mathematics learning. I, therefore, recommend that mathematics is taught in English from grade 1 up to grade 12 in all schools. The teaching of mathematics in Isizulu must cease.

- **Inability to complete ATPs** – Many teachers do not complete the ATP given to them. There are many reasons for teachers to find themselves behind the syllabus or ATP. One reason can be emanating from teachers themselves and others from the side of the learners. Some teachers stay in the staffroom and do not attend to their periods. Some are frequently absent from school and some keep on repeating the same thing which takes the most time. On the learners' side, the teacher finds himself not able to move swiftly with the lesson because learners do not understand at all. The teacher cannot fly alone with the lesson leaving all the learners behind. Most teachers are then forced to utilise the extra lessons to catch up with the ATP. The disadvantage of using extra classes is that there are learners who have genuine reasons for not being part of the extra class. Therefore, those learners will be left behind and add to learners

that will fail mathematics during assessment times. I, therefore, recommend that Departmental Heads and Subject Advisors monitor the ATP very closely and make all mathematics teachers accountable for their progress.

- **Lack of knowledge from previous grades** – The study discovered that teachers complain that many learners lack knowledge from previous grades, especially from primary schools. Secondary school teachers always blame teachers at the primary school level.

- **Integrating previous knowledge with the current knowledge** – The research shows that learners fail to link the Number Patterns they learnt in previous grades with the current knowledge. They need to understand that the same Number Patterns they learnt in lower grades can be used in their learning in the higher classes. I recommend that teachers need not revise the previous work but create time to reteach it for better understanding before the new concepts are introduced.

- **Grade 8 and 9 problems** – In many schools, there is an outcry that almost all secondary schools neglect grades 8 and 9. Those not performing well in FET are demotivated as early as grades 8 and 9. Many learners lose the love of mathematics in grades 8 and 9 when they are taught by incompetent and demotivated teachers without mathematics passion. I, therefore, recommend that grades 8 and 9 be taught by strong and passionate teachers. A strong foundation of mathematics must be laid in these two classes to ease the work for teachers in the FET band.

- **Linking Senior Phase (SP) to GET and FET** – During interviews and questionnaires participants cited that there is no link between Senior Phase and FET. The two bands are working in silos. One class for the Senior Phase is on the primary school premises and the other two in the secondary school premises. This is happening for all the schools in KwaZulu- Natal and other surrounding provinces. I then recommend that the grade 7 class be taken to the secondary premises. That means secondary school must start from grades 7 to 12 or grades 7 to 9 can also be a stand- alone Junior Secondary school.

- **Poor results especially in grade 12** – The main concern of all stakeholders of education is the poor performance of mathematics in grade 12 or Senior Certificate results. Mathematics is the only subject that produces less than 60% of all the years in grade 12. Number Patterns is one of

the topics that contributes to poor performance in mathematics across the grades. I, therefore, recommend that the education system visit the sources that produced teachers and make some amendments that will produce quality teachers that will change the status quo of the mathematics performance in the country.

- **Teachers and teaching of mathematics** - most of the teachers teaching mathematics experience challenges in teaching mathematics as many schools lack support from the department in terms of resources. Number Patterns is one of the topics that needs particular material for the learners to understand clearly. Most of the schools do not even have textbooks as teaching material.

6.7 Conclusion

This study explored mathematics teachers' challenges in using primary Number Pattern concepts when transitioning to secondary school level in Amajuba district schools. Research discovered strategies and solutions that can be implemented by mathematics teachers to overcome the challenges teachers encounter when teaching Number Patterns transitioning from Senior phase to FET level. Schools in Amajuba district supplied the researcher with requested information without complaint.

It was demonstrated how constructivism as the theoretical framework for this research assisted with realising the objectives of the investigation. Participatory questionnaires, interviews, and lesson observations were utilised as a method for collecting data. The researcher was engaged in a progression of discussions with the teachers involved, as they are the ones who experience challenges in their respective mathematics classrooms. This study endeavoured to discover the facts, action them, reflect, perform additional investigation, and bring about transformation.

The primary findings of this study were also provided and described to react to the key and subsidiary research questions. Nine challenges were presented and described, namely: Use of problem-solving in the classroom; language switching especially in grade 4; inability to complete ATPs; lack of knowledge from previous grades; integrating previous knowledge with the current knowledge; grades 8 and 9 not taught properly; linking Senior Phase (SP) to GET and FET; poor results especially in grade 12; and teachers teaching mathematics problems. All

the challenges listed above are the causes of poor performance in Number Patterns escalating to the overall performance in mathematics.

It was very important for this study to be conducted as there is a crisis in mathematics underperformance in most South African schools. The research questions were well answered in this study. From the participants responses it was discovered that mathematics teachers need development in teaching of mathematics including Number Patterns. It was also recommended that teachers undergo a retraining of mathematics teachings whereby methodology and content aspects are given a priority. Schools also need to be encouraged to adopt using of problem solving in their mathematics teaching. Although learners also contribute to poor performance of mathematics, they are not accountable as much as their teachers.

I am very optimistic that this study will help a lot of teachers in overcoming the challenges they have when teaching Number Patterns. I further encourage more researchers to do further research on the challenges mathematics teachers encounter in using Number Patterns concepts from primary school at the secondary school level. I am very biased that it is not teachers who are failing to teach mathematics properly but there are so many factors that need to be researched that contribute to learners under performance in Number Patterns and mathematics as a whole. The findings of this study as the leader of the subject in my district made me took the decision of sharing them with other colleagues from the province as a member of the provincial team. It is very important that these findings are cascaded to every teacher in the province and even nationally.

I've been an internal moderator for Mathematics in the province for the past six years producing qualitative reports after every writing and marking of matric NSC examinations. This gave me the opportunity to voice out my findings to every body who will be reading my report. It also gives me the opportunity to meet different people from different provinces and educational levels. I also use the same platform when we meet in Pretoria to share my findings. Policy makers and Umalusi people use to be part of the meeting and I use the opportunity to voice out frustrations from teachers. It is very important that my findings and concerns from teachers are escalated and reach the ears of the people concerned.

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APPENDICES

APPENDIX A- ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

12 November 2021

Lionel O'Brian Vukile Buthelezi (209529058)
School Of Education
Edgewood Campus

Dear LOV Buthelezi,

Protocol reference number: HSSREC/00003371/2021
Project title: Exploring mathematics challenges in using number patterns concepts from primary school at the secondary school level in Amajuba District schools
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 14 September 2021 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 12 November 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

APPENDIX B – LETTER TO THE DEPARTMENT

3 July 2021

TO: DIRECTOR/CES -TLS AMAJUBA DISTRICT

FROM: L.O.V BUTHELEZI

CONTACT: [redacted]

SUBJECT: Application to conduct research in the schools of Amajuba District

Dear Sir

1. The above subject refers.

2. I would like to request permission to conduct a study for the requirement of a Master of Education in Mathematics Education.

3. The topic is: **Exploring mathematics teachers' challenges in using primary number pattern concepts at the secondary school level in Amajuba district schools.**

Your cooperation in this matter will be highly appreciated.

Yours Faithfully

[redacted]

L.O.V Buthelezi

APPENDIX C - LETTER TO THE PRINCIPALS

12 July 2021

TO: PRINCIPAL

FROM: L.O.V BUTHELEZI

CONTACT: [redacted]

SUBJECT: Request to conduct research in your schools

Dear Sir

1. The above subject refers.
2. I would like to request permission to conduct a study for the requirement of a Master of Education in Mathematics Education.
3. The topic is: **Exploring mathematics teachers' challenges in using primary number pattern concepts at the secondary school level in Amajuba district schools.**

Your cooperation in this matter will be highly appreciated.

Yours Faithfully

[redacted]

L.O.V Buthelezi

APPENDIX D – PERMISSION LETTER FROM THE DEPARTMENT

KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

Enquires: E.N Sithole **Ref : Amajuba District** **Date : 12 July 2021**

Mr L.O.V Buthelezi
University of KwaZulu Natal
Durban
4000

Dear Mr Buthelezi

SUBJECT: **PERMISSION TO CONDUCT RESEARCH IN AMAJUBA DISTRICT SCHOOLS**

1. The above subject refers.
2. The permission to conduct research in Amajuba Primary and Secondary schools has been granted.
3. Your confidentiality with the critical information of our schools will be highly recommended.
4. Your research mustn't affect or disturb the hours of teaching in the schools you will select for your research.
5. Wishing you all the best in your studies.
6. Should you need any further assistance don't hesitate to contact our office.

Thank you

[redacted]

Mr E.N Sithole
CES: FET
AMAJUBA DISTRICT

...Leading Social Compact and Economic Emancipation
Through a Revolutionary Education for All...

Private Bag X6618, NEWCASTLE, 2940
113 Panorama Drive, Newcastle, 2940
Tel: 034 382 4500 **Fax:** 034 3172158

GROWING KWAZULU-NATAL TOGETHER

APPENDIX E – INFORMED CONSENT LETTER

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

My supervisor is Prof J Naidoo who is located at the School of Education, Edgewood campus, University of KwaZulu-Natal (UKZN).

Contact details: Room CU 118, Main Tutorial Building, Edgewood Campus, UKZN.

Email: naidooj2@ukzn.ac.za

Phone number: 031 2601127

CONSENT

I…… (full names of participant/principal) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participate in the research project by L.O.V Buthelezi.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

I have been allowed to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at the details provided above.

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

I hereby provide consent to participate in the research:

_____ _____

Signature of Participant **Date**

_____ _____

Signature of Witness **Date**

(Where applicable)

Buthelezi Lionel Obrian Vukile

School of Education, College of Humanities,

University of KwaZulu-Natal,

Edgewood Campus

Dear Participant

INFORMED CONSENT LETTER

My name is **Lionel Obrian Vukile Buthelezi.** I am a **Masters's Degree** candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in researching the following topic: **Exploring mathematics teachers' challenges in using primary number pattern concepts at the secondary school level in Amajuba district schools.** To gather the information, I am interested in asking you some questions.

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person but reported only as a population member opinion.
- The interview may last for about 45 minutes to 1 hour.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.

• If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded with the following equipment:

Equipment	**Willing**	**Not willing**
Audio equipment		
Photographic equipment		
Video equipment		

I can be contacted at:

Email: **v**[redacted]

Cell: [redacted]

APPENDIX F – LETTER FROM EDITORS

Angela Bryan & Associates

[redacted]
Westville

Date: 11 September 2023

To whom it may concern

This is to certify that the Master's Thesis: Exploring mathematics teachers challenges in using Number Pattern concepts from primary school at secondary school level in Amajuba District schools written by Lionel Obrian Vukile Buthelezi has been edited by me for language.

Please contact me should you require any further information.

Kind Regards

Angela Bryan

[redacted]

APPENDIX G – TURNITIN CERTIFICATE

Exploring mathematics teachers' challenges in using Number Pattern concepts from primary school at secondary school level in Amajuba district schools.

ORIGINALITY REPORT

19%	17%	7%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of KwaZulu-Natal Student Paper	2%
2	ujcontent.uj.ac.za Internet Source	1%
3	repository.up.ac.za Internet Source	1%
4	etd.uwc.ac.za Internet Source	1%
5	Submitted to University of South Africa Student Paper	<1%
6	www.researchgate.net Internet Source	<1%
7	scholar.ufs.ac.za Internet Source	<1%
8	aadcice.hiroshima-u.ac.jp Internet Source	<1%
	journals.ums.ac.id	

APPENDIX H – QUESTIONNAIRE FOR MATHEMATICS TEACHERS

1. School information

1. Name of the school: _____
2. Type of the school: Prim / Sec _____
3. Circuit: _____
4. Grades in the school: _____
5. No. of learners doing mathematics (GET & FET): _____
6. No. of teachers teaching mathematics: _____

2. Teacher information Teachers Profile

1. Surname: _____
2. Title: _____+
3. First Name(s): _____
4. Gender: _____
5. Age group: (tick) ☐ 20-30 ☐ 31-40 ☐ 41-50 ☐ 51-65
6. Highest Mathematics Qualifications: _____
7. Subjects and Grades Teaching: _____
8. Number of years teaching mathematics (GET/FET): _____

3. Challenges in teaching number patterns

1. Does your school participate in problem-solving Olympiads?

☐ Yes ☐ No

2. Do you teach number patterns in GET or FET?

☐ GET ☐ FET ☐ Both

3. Do you think your learners have enough previous knowledge of number patterns?

☐ Yes ☐ No

4. Do the teachers teaching mathematics in your school move with their learners to the next grade?

☐ Yes ☐ No

5. In which phase are you comfortable teaching number patterns?

☐ GET ☐ FET ☐ Both

6. Development

6.1 Do you need development in the teaching of number patterns?

☐ Yes ☐ No

6.2 In which part/subtopic of number patterns do you need development?

_____

6.3 Why do you think you need development in that particular subtopic?

☐ Lack of Background ☐ Topic challenging

☐ Lack of problem-solving skills ☐ Learning more about the topic

7. List challenges you encounter in the teaching of number patterns and how they can be addressed:

Challenges	Possible solutions

8. Do you think there is a problem in using primary number pattern concepts at the secondary school level?

☐ Yes ☐ No

If yes, where do you think the problem is?

APPENDIX I – INTERVIEWS SCHEDULE

1. Which grades have you been teaching for the past 3 years?

   _____

2. (a) How are your learners performing in the number patterns section in all the grades you are teaching?

   _____

   _____

   _____

   (b) What do you think is the cause for poor performance in number patterns?

   _____

   _____

   _____

   Where do you think the problem comes from?

   _____

   _____

   _____

3. What do you think can be done to resolve this problem?

   _____

   _____

   _____

4. Do you see any interconnection or disconnection in linking the GET and FET number patterns concepts?

5. _____

_____

_____

6. Any other comments or inputs about this topic?

_____

_____

_____

APPENDIX J – LESSON OBSERVATION SCHEDULE

	Response by mathematics teacher	Comments
Name of the school		
Name of the teacher		
Grade Teaching		
No of number patterns lessons as per ATP.		
No of number patterns lessons taught by the teacher.		
No exercises given to the learners for number patterns.		
No formal tests given in number patterns.		
No informal tests given in number patterns.		
Average performance in the formal test.		
Is there any investigation or assignment about the number patterns given to the learners?		
How often are the learners exposed to problem-solving?		
Does the school participate in problem-solving activities? E.g. Olympiads		

APPENDIX K – DOCUMENT ANALYSIS

1. Overall achievement rates in Mathematics

	Grade 7			Grade 8			Grade 9			Grade 10			Grade 11			Grade12	
	No. Wrote	No. passed.	Pass %	No. Wrote	No. Passed	Pass %	No. Wrote	No. Passed	Pass %	No. Wrote	No. Passed	Pass %	No. Wrote	No. Passed	Pass %	No. Wrote	No. Passed
2020																	
2019																	
2018																	
2017																	
2016																	

2. Diagnostic question analysis for Mathematics paper 1 Grade 12

	Average performance percentage per topic					
Year	**Algebra**	**Number Patterns**	**Functions & Graphs**	**Finance**	**Calculus**	**Probability**
2020						
2019						
2018						
2017						
2016						

3. Performance per subtopic in number patterns in Grade 12 2020 examinations

	Poorly performed	Fairly performed	Well performed	Understanding%
Quadratic Patterns				
Arithmetic Sequence				
Geometric Sequence				
Arithmetic Series				
Geometric Series				
Sigma notation				
Sum to infinite				