ALIGNMENT BETWEEN SENIOR PHASE MATHEMATICS CONTENT STANDARDS AND NUMERIC AND GEOMETRIC PATTERNS' WORKBOOK ACTIVITIES

By

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DEDICATION

It is with my genuine gratitude and warmest regards that I dedicate this dissertation to my supervisor Dr Z.B. Dhlamini and co-supervisors Dr K.M. Chuene and Dr B. Chigonga for their commendable contribution and constant feedback during the process. I must express my gratitude to the Department of Mathematics, Science and Technology Education lecturers for their helpful comments during presentations. I gratefully acknowledge my mother Ms L.M. Qhibi, my brother G.G. Qhibi and sisters, Ms D. Qhibi, Ms M.P. Qhibi and Ms T.P. Qhibi for their support and inspiration. A very special thank you goes to Mr L.S. Maredi for his tireless support when conducting this study. Finally, I would like to thank my children Rhandzu and Tebogo for giving me chance to focus on this study.

DECLARATION

I declare that ALIGNMENT BETWEEN SENIOR PHASE MATHEMATICS CONTENT STANDARDS AND NUMERIC AND GEOMETRIC PATTERNS' WORKBOOK ACTIVITIES is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

.... 12 September 2019
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Signature **Date**

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ABSTRACT

Alignment between content standards, instruction, assessment and learning materials assists in achieving the intended content in the classroom. The purpose of this study was to explore the alignment between Senior Phase Mathematics Content Standards (SPMCS) and numeric and geometric patterns' workbook activities. The problem was that teachers sometimes use the Department of Basic Education's workbooks interchangeably with textbooks, while their purpose is to supplement textbooks and provide worksheets for the learners. The alignment status of the Department of Basic Education (DBE) senior phase mathematics' workbooks could not be found in the literature. Mixed methods research and document analysis were employed to explore the status of alignment between SPMCS and DBE workbook activities on Numeric and Geometric Patterns (NGP). This was aimed at highlighting the status of alignment in terms of the content structure and the alignment indices through the use of alignment model of Webb (1997) and of Porter (2002).

The findings of this study revealed that the alignment between SPMCS and DBE workbook activities on NGP in terms of the categorical concurrence, depth of knowledge consistency and range of knowledge correspondence ranges from 'acceptable' to 'full' level of agreement. However, content beyond the scope of the content standards was found in Grade 7 and Grade 8 DBE workbook activities on NGP. The computed alignment indices for Grade 7, Grade 8 and Grade 9 range from moderate to strong alignment. Besides, weak and strong discrepancies were identified, which need to be addressed to improve the content structure of the DBE workbooks. This study recommends two alignment models to explore the alignment between educational components for comprehensive results and complementation. In addition, studies such as this should be conducted to enhance the quality in developing assessments in future.

KEY CONCEPTS

Alignment; assessment; content standards; learning materials; workbooks; numeric patterns and geometric patterns.

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LIST OF ACRONYMS

ACER	: Australian Council for Educational Research
ACT	: American College Testing
ANA	: Annual National Assessment
CAPS	: Curriculum and Assessment Policy Statement
CCSS	: Common Core State Standards
DBE	: Department of Basic Education
DoK	: Depth of Knowledge
HKDSE	: Hong Kong Diploma of Secondary Education
JCPS	: Jefferson Country Public School
NAEP	: National Assessment of Educational Progress
NGP	: Numeric and Geometric Patterns
RNCS	: Revised National Curriculum Statement
SEC	: Survey of Enacted Curriculum
SPMCS	: Senior Phase Mathematics Content Standards
TIMSS	: Trends in International Mathematics and Science Study
TREC	: Turfloop Research and Ethics Committee

1. CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Introduction

Alignment in educational components is described as “the degree to which expectations and assessments are in agreement and serve in conjunction with one another to guide the system towards students learning what is expected” (FitzPatrick, Hawboldt, Doyle, & Genge, 2015, p.1). Alignment in educational components such as; content standards, instruction, assessment, learning materials and professional development ensures that the components are in line with one another (Porter, 2002). It is believed that alignment between educational components is capable of enhancing learner performance (Biggs, 2014; Watermeyer, 2012). Consequently, alignment becomes very critical in facilitating curriculum delivery (Riet, 2015). The principle of alignment highlights that the content standards must be cognitively aligned to assessment (Capate & Lapinid, 2015).

Assessment in the senior phase mathematics classroom is very important and acts as a quantitative method for evaluating the quality of the learning process (Dzelzkaleja & Kapenieks, 2016). Assessment as a fundamental element to evaluate curriculum objectives, ensures that acquired knowledge and skills are evaluated to facilitate curriculum delivery (Baird, Hopfenbeck, Newton, Stobart, & Steen-Utheim, 2014). Assessment remains the most effective measurement tool in teaching and learning. Hence, it is vital for assessment to be designed in close relation to the content standards (Webb, 1997).

Content standards are broad statements that outline what learners should know and be able to do as a result of their public schooling (Addonizio & Kearney, 2012). The purpose of the content standards is twofold: as the major curricular guide tool and as the basis for assessment (Zajda, 2015). In South Africa, the content standards for each grade and each subject are stipulated on the

Curriculum and Assessment Policy Statement (CAPS). This is aimed at achieving the expected learning outcomes in the classroom. The content standards are also used in developing learning materials that assist in guiding teachers' instruction. This is done to ensure alignment between content standards, instruction and learning materials.

Learning materials are core components for effective curriculum delivery, hence, educators use a variety of learning and teaching support materials for effective teaching (Riet, 2015). Learning materials include study guides, textbooks, workbooks and many more. This study focused on the Department of Basic Education (DBE) workbooks, as one of the learning materials used in the senior phase mathematics classrooms. The purpose of the DBE workbooks is to supplement textbooks and provide worksheets for the learners (DBE, 2013). Most teachers depend on textbooks for their instructional guidance (Smith, Hanks, & Erickson, 2017). The DBE workbooks are designed in the form of worksheets to assist teachers. This study focused on patterns, functions and algebra, one of the content areas in mathematics.

Patterns, functions and algebra, has five topics, which are: numeric and geometric patterns; algebraic expressions; algebraic equations; functions and relationships; and graphs. However, this study explored a topic on Numeric and Geometric Patterns (NGP), to explore alignment between Senior Phase Mathematics Content Standards (SPMCS) and the DBE workbook activities on NGP. Numeric patterns are patterns presented in the form of a sequence of numbers, while Geometric patterns are number patterns represented diagrammatically (Collocott, Dowse, Gerrard, & Maharaj, 2013). These two types of patterns are taught in the senior phase mathematics classroom to enable learners to deal with patterns in the classroom and beyond.

1.2 Background of the Study

Alignment studies between educational components have been conducted locally and internationally (Hoadley & Galant, 2016; Ndlovu & Mji, 2012; Polikoff, 2015; Porter, 2002; Webb, 1997). The findings have revealed that alignment as well as misalignment exists between the educational components (Daro, Hughes, & Stancavage, 2015; Ndlovu & Mji, 2012; Polikoff, 2015; Smith, 2012; Tannenbaum, Baron, & Kannan, 2015). Alignment exists when content standards are taken into consideration on instruction, assessment and development of learning materials. On the other hand, misalignment exists when content standards are not taken into consideration on educational components. Misalignment in educational components has a negative impact on the quality of the education system (Dwyer, 2017). Hence, it is very critical to align educational components, to enhance curriculum delivery and to achieve the expected outcomes (Biggs, 2014). Only limited literature on alignment between content standards and DBE workbooks was found on local alignment studies.

The South African Department of Basic Education has developed the workbooks and has distributed them annually to support Grade 1 to Grade 9 numeracy and literacy in the public schools (Venkat & Graven, 2017). It has been noted that the DBE workbooks are used interchangeably with the textbooks, which shows that their intended purpose is sometimes overlooked (Mathews, Mdluli, & Ramsingh, 2014). Again, the alignment status of DBE workbooks is also questioned by the researcher, since little literature on the alignment of DBE workbooks and content standards has been produced. Hence, the focus of this study was to explore the alignment between SPMCS and NGP's workbook activities. This is done to highlight the status of alignment between the SPMCS and the DBE workbook activities on NGP as the focus of this study.

This study was prompted by the fact that little literature was noted on alignment studies between the content standards and the DBE workbooks in South Africa. Nonetheless, some studies confirmed that assessments and learning materials are sometimes developed without considering the content standards. For instance, international alignment studies conducted between the content standards and the assessment, revealed that alignment is not satisfactory (Daro et al., 2015; FitzPatrick et al., 2015; Smith, 2012; Tannenbaum, Baron, & Kannan, 2015). Misalignment between the content standards and the assessment is a serious challenge, which may impact negatively in the process of shaping teaching and learning (Dwyer, 2017). Misalignment was found not only on content standards and assessment, but also learning materials such as textbooks were affected (Polikoff, 2015).

Polikoff (2015) evaluated how well aligned the textbooks are, to the United States of America's Common Core State Standards (CCSS) in mathematics, and the findings revealed misalignment. Misalignment between content standards and textbooks should be a major concern, since textbooks are used to guide teachers' content of instruction (Hess & McShane, 2013). Furthermore, Polikoff (2015) cautions that textbooks should not be judged by the outside cover caption that says 'curriculum aligned', because other captions are deceiving. The alignment status of textbooks should be confirmed through alignment studies conducted by evaluators of learning materials, teachers, researchers and many more. For instance, the fact that the DBE workbooks' cover page has been labelled 'CAPS aligned' did not stop the researcher from exploring their alignment with the content standards. This study was conducted to explore the status of alignment between SPMCS and the DBE workbook activities on NGP.

Hopefully, this study may contribute to the body of knowledge on alignment studies focusing on alignment between the content standards and the DBE workbook activities on NGP. Consequently, the study may afford South Africans an opportunity to enhance the development of quality learning materials and assessments in future. The researcher believes that the benefits could be extended to the curriculum developers, teachers, assessment developers and authors of learning materials, since discrepancies and similarities are highlighted.

1.3 Research Problem

Ideally, SPMCS should be based on five main content areas as stipulated in CAPS, namely: (1) numbers operations and relationships; (2) patterns, functions and algebra; (3) space and shape; (4) measurement; and (5) data handling (DBE, 2011). This study focused on patterns, functions and algebra to explore a topic on NGP. SPMCS should be aligned with the learning materials, instruction and assessments, in order to enhance effectiveness in the teaching and learning of mathematics (Porter, 2002). Learning materials such as textbooks, are designed to support teaching and learning, and to transfer content standards into the classroom (Oates, 2014). However, DBE workbooks are also utilised to support teaching and learning (DBE, 2013).

The development of DBE workbooks was mainly to supplement textbooks and to provide worksheets to the learners (DBE, 2013). Mathews et al. (2014), claim that DBE workbooks are used for different purposes: (1) in isolation from other resources; (2) integration; (3) homework; (4) assessment preparations; and (5) for compliance. In essence, DBE workbooks are not meant to be used in isolation or for compliance, but are designed to supplement textbooks for effective learning and teaching (DBE, 2013). Besides, DBE workbooks are best suited as practice tools for curriculum (Hoadley & Galant, 2016). However, some teachers use DBE workbooks just to fulfil departmental requirements of completing four worksheets per week (Mathews et al., 2014).

The call for ‘one textbook per learner per subject’ is not a good idea, since learners will be limited to one resource for cognitive development (Baporikar, 2014). Riet (2015) highlights that some teachers use a variety of learning materials for learning and teaching. Jenna (2017) asserts that, reinforcement of concepts can be done through good management of homework. In addition, it is noted that some teachers replace textbooks with DBE workbooks for teaching and learning (Mathews et al., 2014), while the primary role of DBE workbooks is to supplement textbooks and to provide worksheets for the learners (DBE, 2013).

This creates serious gaps in effective teaching and learning, since little literature has been found on the alignment of the DBE workbooks and the content standards. So, if little literature has been observed on alignment between content standards and DBE workbook activities, the researcher responded by exploring the alignment between SPMCS and DBE workbook activities on NGP.

This study was conducted to explore the alignment status between SPMCS and DBE workbook activities on NGP. This aimed at highlighting the status of alignment in terms of the content structure and the alignment indices. The alignment in terms of the content structure was explored through the use of Webb's (1997) alignment model while alignment in terms of the alignment indices were calculated with the use of Porter's (2002) alignment model.

1.4 Purpose of the Study

The purpose of this study was to explore the degree of alignment between the senior phase mathematics content standards and the Department of Basic Education workbook activities on numeric and geometric patterns. To achieve this purpose, this study addressed the following: one main question, and two sub-questions.

1.4.1. Research Questions

The main research question was as follows:-

- To what extent are the senior phase mathematics content standards aligned with the Department of Basic Education workbook activities on numeric and geometric patterns?

The sub-research questions were;

- What content structure do the senior phase mathematics and Department of Basic Education workbook activities on numeric and geometric patterns have?

- How do the senior phase mathematics content standards align with the Department of Basic Education workbook activities on the numeric and geometric patterns' content standards?

1.5. Significance of the Study

The findings of this study may be useful in strengthening curriculum, assessment and learning materials as the status of alignment and discrepancies between SPMCS and DBE workbook activities on NGP were highlighted. This study may also be used to form the basis for future researches, since two alignment models (Webb, 1997; Porter, 2002) and two research approaches (qualitative and quantitative) were employed to produce comprehensive results. This was done for the purpose of triangulation paradigm and theory triangulation. Hopefully, this study may contribute towards the realisation of the importance and benefits of aligning assessment and learning materials with the content standards. This is anticipated since aligning assessment and learning materials is critical in the classroom for effective curriculum delivery (Riet, 2015).

Consequently, this study may assist teachers as pioneers of knowledge to spot good qualitative assessments and learning materials in future. This study may also assist teachers to develop qualitative assessments. Theoretically, this study may add to the literature dealing with alignment studies between educational components, which will consequently improve the education system in South Africa (Biggs, 2014). Furthermore, the researcher used existing theories to guide this study, which may also guide researchers in the application of the alignment models. It is hoped that this study will minimise problems related to alignment between educational components. Again, this study may contribute to guiding the Department of Basic Education as to whether mathematics senior phase workbooks can be recommended as teaching tools or not, since some teachers use them for their teaching.

1.6. Dissertation Outline

This dissertation is divided into five sections, namely; Chapters One, Two, Three, Four and Five. The chapters have been outlined below:

1.6.1. Chapter One

This chapter gives an overview of this study by outlining the introduction and the background orientation to this study. The introduction highlights what the key concepts are and how they are used in the senior phase mathematics classrooms. This chapter also reviews the background literature of the key concepts in relation to this study. In addition, the chapter goes on to highlight the purpose of this alignment study, which is to explore the status of alignment between senior phase mathematics content standards and the Department of Basic Education’s workbook activities on numeric and geometric patterns. Hopefully, the findings of this study may contribute to the body of knowledge on alignment studies and thus help to enable future studies.

1.6.2. Chapter Two

This chapter begins with description of alignment procedures to illuminate the concept of alignment and its procedures. This chapter focuses on reviewing the literature, through comparing and contrasting findings by other researchers in order to guide this study appropriately. The implications of the findings by other researchers are also analysed critically in this chapter, to highlight similarities and discrepancies on alignment studies. This is aimed at highlighting the importance of developing appropriate assessments and learning materials. The researchers have highlighted the importance of aligning the educational components such as; content standards, content of instruction, assessments and learning materials to improve performance and quality of the education system.

1.6.3. Chapter Three

This chapter outlines the research methodology employed in this study, which is mixed methods research, to produce quality and comprehensive results. This chapter discusses the educational research approaches first, in order to outline the extent to which each approach can be applied. The details on how data were collected and analysed are also outlined in this chapter. The procedures employed in data collection instruments, data collection and data analysis are also described in this chapter. The trustworthiness of data collected by different content analysts was measured with the use of Krippendorff alpha, to determine the congruity of their agreements and disagreements. The chapter also covers the quality criteria to affirm that the objectives and the quality expected have been achieved.

1.6.4. Chapter Four

This chapter presents the interpretation of the results as well as the findings of this study. Results are analysed and interpreted following the alignment models of Porter (2002) and of Webb (1997). Tables and graphs are used to help present the results.

1.6.5. Chapter Five

This chapter presents the summary of findings and the recommendations to enhance alignment between the content standards and the Department of Basic Education workbook activities. Contributions made by this study and the limitations are also discussed in this chapter. The conclusion in relation to the research questions and the problem statement is also highlighted in this chapter. The following chapter will be focusing on the literature review.

2. CHAPTER TWO
LITERATURE REVIEW

2.1. Introduction

A comprehensive review of literature was conducted to compare and contrast other alignment studies related to this study. The comparison was done to highlight the implications of the alignment studies, and also to outline their significance to this study. The review of the literature focused on the following dimensions: (1) alignment procedures; (2) alignment studies between content standards and assessments; (3) alignment studies between content standards and learning materials; (4) DBE workbooks; (5) numeric and geometric patterns and (6) cognitive levels. These dimensions were analysed as fundamental fields to enrich this study. This chapter begins by describing the alignment of educational components as a way of illuminating the importance of aligning educational components. The researcher is of the view that these various dimensions have contributed towards achieving the primary purpose of this study.

2.2. Alignment Models

The alignment of educational components can be defined as the link between the intended learning outcomes and the crucial educational components fostering those learning outcomes, which include: curriculum, assessments and instruction (Hutchings, 2016). Over and above that, the principles of alignment between educational components include connection between: content standards and instruction; content standards and assessment and also instruction and assessment (Davis-Becker & Buckendahl, 2013). Figure 2.1 below illustrates the principles of alignment in an educational system.

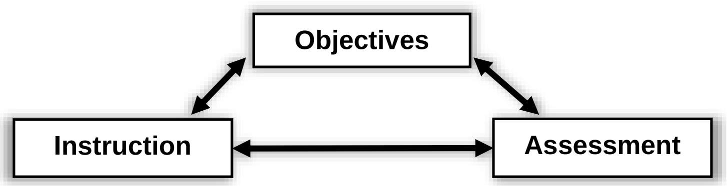


Figure 2. 1: Principles of alignment (Capate & Lapinid, 2015, p.2)

Figure 2.1 above clearly illustrates the basic principles of alignment in an educational system. It shows how objectives or content standards should be cognitively aligned to assessment; content standards to instruction and instruction to assessment (Capate & Lapinid, 2015). The perception is that effective teaching and learning both occur when these are directly linked to the content standards. This has a high possibility of resulting in quality education and high performance (Ennis, 2014). In contrast, misalignment occurs when the intended curriculum does not match both the implemented and the attained curriculum (Marzano & David, 2013). In most cases, misalignment results in underperformance in schools due to compromised quality (Salina, Girtz, & Eppinga, 2016).

The factors contributing to the misalignment of educational components, are inter alia, assessment activities not linked to content standards and instruction not cognitively aligned to the assessment (Collymore, 2013). Collymore (2013) further highlight that misalignment between instruction and assessment occurs when teachers adequately teach at lower cognitive levels when they were supposed to teach at higher cognitive levels, or vice-versa. Hence, alignment is a very critical aspect in promoting high quality and enhanced performance in an educational system (FitzPatrick et al., 2015). Ndlovu and Mji (2012) revealed that there are three most frequently used alignment models to judge alignment between content standards and assessment. The alignment models include but are not limited to the following: (1) the Webb model, (2) the Achieve model, and (3) Surveys of Enacted Curriculum (SEC), which is commonly known as Porter's alignment model. A detailed exploration of the alignment models is presented below.

2.2.1. Models of Alignment

Firstly, Webb's (1997) alignment model was explored. Webb (1997) used six criteria of content focus to explore alignment between content standards and assessment, namely: (1) Categorical concurrence; (2) Depth of knowledge (DoK) consistency; (3) Range of knowledge correspondence; (4) Structure of knowledge comparability; (5) Balance of representation; and (6) Dispositional consonance. First, the categorical concurrence, verifies whether content standards and assessment covered one and the same content. Second, DoK consistency classifies content standards and assessments in terms of cognitive levels. Third, the range of knowledge correspondence compares content standards and assessments according to their breadth of knowledge. Fourth, structure of knowledge comparability indicates the extent to which the learners are expected to form relationships among ideas.

Fifth, the balance of representation is used to clarify the weighting of topics on both content standards and assessment. Sixth, the dispositional consonance indicates the level of different qualities such as beliefs, attitudes and habits. Webb's model recommends the use of content analysts who are experts in the content area such as: district content area supervisors, subject advisors and content area teachers, to map the content standards with the assessment. Content analysts have to be trained before conducting analyses to be able to map content standards with assessment. The use of a large number of content analysts is believed to be capable of increasing the reliability of the results (Armes, 2016).

Secondly, Achieve's alignment model was explored. The Achieve's alignment model can be used to compare content standards of different states as well as content standards and assessment. This model uses five dimensions to explore the alignment between content standards and assessment, namely; (1) content centrality, (2) performance centrality, (3) source of challenge, (4) balance, and (5) range (Rothman, Slattery, Vranek, & Resnick, 2002). The dimensions have been discussed below.

First, content centrality refers to the degree of alignment between an assessment activity and content standard (Greive, 2012). Second, performance centrality indicates the degree to which the cognitive level of the assessment activity is aligned to the cognitive level of the content standard (Greive, 2012). Third, source of challenge is the extent to which the cognitive levels of the assessment activities correspond with the range of cognitive levels of the content standards. Fourth, balance examines the assessment activities that are aligned to the content standard and further evaluate if the assessment activities have the same emphasis as on the content standards. Last, the range refers to the proportion of the content standard that is mapped to at least one assessment activity. The dimensions correspond to most of the Webb's criteria of content focus. A panel of content analysts is also recommended like in Webb's alignment model. However, Achieve model utilises the test blueprint, which could obscure the purpose of the assessment, while Webb allows content analysts to map the content standards and assessment activities independently.

Thirdly, Porter's (2002) alignment model was explored. Porter's alignment model differs from both the Webb's alignment model and the Achieve's alignment model, since it can be used to explore alignment between content standards, assessment and instruction, while Webb and Achieve's alignment model can be used to explore alignment between content standards and assessment (Sireci & Faulkner-Bond, 2014). Porter's alignment model and Webb's alignment model differ in terms of coding the content and the assessment. In Porter's alignment model, content analysts code using a common framework, while in Webb's alignment model, coding is done individually by the content analysts. Porter's alignment model uses two context matrices to calculate alignment index which are: content matrix and assessment matrix. The content matrix covers content topics or sub-topics and cognitive levels, while the assessment matrix covers assessment activities and the same cognitive levels used on the content matrix. Porter's alignment model is represented by the index below:

$$\text{Alignment index} = 1 - \frac{\sum |x - y|}{2}$$

where x denotes the cell proportions in the content matrix and y denotes the cell proportions in the assessment matrix. Porter's alignment model uses a rating scale between 0 and 1, where 0 means no alignment and 1 means perfect alignment.

Generally, all the alignment models mentioned above, have an element of commonality which requires a set of content standards and cognitive levels to be clearly defined. This study adopted Porter's (2002) alignment model and Webb's (1997) alignment model to explore the alignment between SPMCS and DBE workbook activities on NGP in terms of the content structure and alignment indices. Two models of alignment were adopted as supported by Newton and Kasten (2013), who claim that coupling two alignment models provide different perspectives and comprehensive results. The Achieve's alignment model was not considered because its alignment criteria require the test blueprint to be considered, which could have deviated from the purpose of this study. Webb's (1997) alignment model was employed to explore the status of alignment in terms of how the content has been structured between SPMCS and DBE workbook activities on NGP, while Porter's (2002) alignment model was employed to explore the status of alignment in terms of the alignment indices.

2.3. Alignment Studies between Content Standards and Assessment

Alignment studies between content standards and assessment have been conducted internationally (FitzPatrick et al., 2015; Higgins, 2013; Tannenbaum et al., 2015) and locally in South Africa (Ndlovu & Mji, 2012). The international alignment studies conducted between the content standards and the assessment revealed misalignment (FitzPatrick et al., 2015; Tannenbaum et al., 2015). Tannenbaum et al. (2015) conducted an exploratory study among panels of teachers to find the extent of convergence between the CCSS and the assessment. A modified Webb's alignment model was used to explore the status of alignment. The findings indicate that in writing, five out of ten CCSS were addressed, in reading, five out of nine literature standards were addressed and seven out of ten informational text standards were addressed. This shows that the status of alignment between the content standards and the assessment is misaligned. The implications are that, the CCSS and the assessment may have content gaps, which could hinder successful implementation of the intended outcomes (El-Maaddawy & Deneen, 2017). It is clear that alignment between assessments and content standards is important and can contribute to learner achievement (Gibbs, 2012)

Similar findings were obtained from a mixed methods study conducted by FitzPatrick et al. (2015), analysing the objectives and assessment tasks in Therapeutics courses using the Webb's alignment model. Unlike in Tannenbaum et al. (2015), FitzPatrick et al. (2015) used the Webb's alignment model without modifications. Their findings revealed misalignment, where half of the assessment activities did not assess the course objectives. The findings of the study by FitzPatrick et al. (2015) and Tannenbaum et al. (2015) confirm that alignment between content standards and assessment is sometimes a challenge that need serious attention. Hence, it is important to align content standards with assessment to help attain learning outcomes (Biggs, 2014).

In another study, the findings obtained by Leung, Leung, and Zuo (2014) also confirm that misalignment between content standards and assessment is sometimes a challenge. Leung et al. (2014) conducted an alignment study between mathematics curriculum expectations and the Hong Kong Diploma of Secondary Education (HKDSE) examination, with the use of the Achieve's alignment model. The findings reveal that the HKDSE examination lacks generic skills such as: learning strategies, collaboration and self-management. The absence of these skills on the HKDSE examination result in misalignment between curriculum expectations and the examination. It is therefore imperative to align curriculum expectations with examination in order to achieve expected learning outcomes (Lilly, Peacock, Shoveller, & Struthers, 2014).

In contrast, Higgins (2013) investigated alignment between CCSS for mathematics and test items of the National Assessment of Educational Progress (NAEP), and the components were found to be significantly aligned. Higgins (2013) used Webb's alignment model to investigate alignment. The focus was on American College Testing (ACT) and Jefferson Country Public School (JCPS) interim assessments. The findings highlight that the JCPS interim assessments are significantly aligned to Grade 8 CCSS, and the ACT explore and 2009 NAEP reveal a high level of alignment with Grade 7 CCSS. However, ACT and 2009 NAEP were not aligned with Grade 8 CCSS. The implications of the findings are that in areas where there is significant alignment, components would be in agreement with one another, but where misalignment prevails, the components would be most unlikely to be in agreement (Watermeyer, 2012). So, it is advisable to conduct alignment in all the grades and all the subjects in the education system, to ascertain consistency and coherence in all the levels (Bernhardt & Bernhardt, 2013).

The findings obtained by Higgins (2013) are similar to those obtained by Duke Escobar (2016). An alignment study was conducted by Duke Escobar (2016) using Webb's (1997) alignment model to investigate alignment between national standards and assessment for elementary mathematics courses in two different universities. The Webb's alignment model was used to compare content standards and assessment for the United States and EI Salvador. The findings highlight that the test items include nearly all the national standards for both university programmes. However, the cognitive levels of the exam items for United States are found to be more properly aligned than in EI Salvador. Despite that, covering all the national standards in the university programmes shows some kind of alignment, but developers of university programmes should ensure deep alignment, where university programmes are cognitively aligned to the national standards (Salina et al., 2016). It is recommended that content standards be clearly stated in terms of cognitive levels to guide instruction and assessment clearly, instead of listing topics only (Webb, 2007). Explicit content standards may facilitate and simplify the link between content standards, instruction and assessment (Capate & Lapinid, 2015). Not only Webb's (1997) alignment model was employed, Porter's (2002) alignment model was employed as well.

Porter's alignment model was employed to evaluate the status of alignment between the Grade 8 Revised National Curriculum Statement (RNCS) and the Trends in International Mathematics and Science Study (TIMSS), for the Grade 8 assessment framework (Ndlovu & Mji, 2012). The findings reveal that the computed Porter's alignment index was 0,75, which is equivalent to 75%. The alignment index shows that alignment is significantly good, since it lies above 70% (Webb, 2007). Besides, the implications are that the 75% may share common language with TIMSS assessment framework; however, the percentage deficit of 25% may disadvantage the learners. At times, alignment was found to be strong between educational components.

An alignment study between content standards and assessment that found alignment to be strongly significant, is the study by Daro et al. (2015). Daro et al. (2015) conducted an alignment study between CCSS and 2015 NAEP mathematics activities in Grade 4 and Grade 8. The findings highlight that 79% of NAEP activities in Grade 4 are significantly aligned to CCSS, while in Grade 8, alignment of NAEP activities to CCSS is significantly strong at 87%. This shows that content standards were taken into consideration when developing NAEP mathematics activities. However, the percentage deficit is a cause for concern. This needs to be improved to produce deep alignment (Salina et al., 2016).

Alignment between content standards and assessment is not only limited to the classroom environment, but extends beyond that. Clough and Montgomery (2015) conducted an alignment study to explore the extent of alignment between

ACT assessments at state college and career readiness standards. Findings reveal that ACT assessments are not only aligned to the expectations of post-secondary education, but also to recruitment, admission, placements and career readiness standards. Alignment between standards for career readiness and college testing assessments is very important, since it verifies whether skills attained are in line with what is expected in the working industry (Anderson & Gantz, 2013). This indicates that what students learn at tertiary level should have vocational significance both in structure and content (Anderson & Gantz, 2013).

A study that confirmed that the high number of content analysts can yield better results was done by Polikoff and Fulmer (2013). They conducted a quantitative study aimed at refining methods for estimating critical values for an alignment index. The findings of their study reveal that using multiple content analysts decreases the standard deviation in the alignment indices, which also indicates less variation. The implication of increasing the number of content analysts is that, the reliability of the results will also be increased, meaning that the standard deviation may have less variation (Armes, 2016). Content analysts were used in this study to map content standards and assessment.

This study sought to explore the alignment between SPMCS and assessment in the form of DBE workbook activities. Therefore, alignment studies between content standards and assessment play a significant role in this study, as they highlight the discrepancies and the importance of aligning the two educational components. The alignment studies between content standards and assessment are critical in guiding this study towards the right direction. The researcher is of the view that this study may contribute immensely towards the development of quality assessments in future.

2.4. Alignment Studies between Content Standards and Learning Materials

Alignment studies between content standards and learning materials have been conducted by researchers, and the challenges that contribute to ineffective implementation of content standards in` classrooms are highlighted. In a study conducted by Polikoff (2015), evaluating the alignment between CCSS in mathematics and textbooks. Porter's alignment model was used to investigate the status of alignment. The results indicate quite substantial areas of alignment between CCSS and textbooks. However, textbooks have been found to be emphasising other cognitive levels such as procedures and memorisation among other cognitive levels. The inference that can be drawn from the findings is that, if textbooks and content standards are not aligned in terms of the cognitive levels, it may result in instruction that is not cognitively aligned, since teachers rely heavily on textbooks to guide them (Zmazek, Lipovec, Pesek, Zmazek, Senveter, Regvat, & Prnaver, 2012). In addition, assessments on learning materials should be cognitively aligned to content standards, by ensuring that the cognitive levels are the same in both the content standards and learning materials (Webb, 2007). This could assist in making sure that all relevant cognitive levels are covered to their depth and breadth when developing learning materials.

Polikoff (2015) further highlights that identification of textbooks that are aligned to content standards is sometimes problematic, as developers of textbooks sometimes deceive users by writing captions on the cover page that say 'curriculum aligned'. People should not be deceived by the outside cover caption of the learning materials, as many of these captions may not be confirmed through alignment studies. Polikoff (2015) relates the deceiving caption outside textbooks with the ice cream label written 'fat free'. This does not mean that people cannot gain kilojoules. An intensive alignment study would need to be conducted to inform the status of alignment. This confirms that the status of alignment on learning materials should not be defined by the 'aligned' caption on the cover page. It is important for Education Departments to conduct alignment studies on learning materials in order to provide guidance on the quality learning materials. Quality learning materials are believed to be capable of improving the value and the quality of the education system (Klees, Samoff, & Stromquist, 2012).

In South Africa, Hoadley and Galant (2016) conducted an investigation of the alignment between CAPS and Grade 3 DBE workbooks. The findings reveal that DBE workbooks are significantly aligned to CAPS and can be used as curriculum tools to assess the content coverage of the curriculum at a systemic level. The variables used to investigate the status of alignment were: content coverage, weighting of content areas and cognitive levels in a limited way. Using weighting of content areas to investigate alignment could be misleading, since weighting is more appropriate for the summative evaluation of tasks (DBE, 2011). It would be advisable for alignment models to have been used by Hoadley and Galant (2016). Investigating alignment between content standards and learning materials should rely heavily on cognitive levels as highlighted by Biggs (2014). Biggs (2014) recommends that for perfect alignment, same verbs should be used on both the content standards and the assessment activities.

Hoadley and Galant (2016) did not use any of the alignment models, i.e. Porter, Webb and Achieve. The researcher viewed the variables used by Hoadley and Galant (2016) to investigate the alignment status between DBE workbooks and CAPS as insufficient. Again, the cognitive levels were used limitedly on the range of numbers and not used on the entire content, which raises questions. Similarly, the findings from the study by Polikoff (2015) are similar to the findings of the study by Hoadley and Galant (2016). All the studies produced significant alignment between content standards and the learning materials, even though not perfect. It is imperative to align content standards and the learning materials, since learning materials help to transfer content standards into the classroom (Biggs, 2014).

Tran (2016) conducted a study to examine alignment between CCSS for mathematics and the three United States high school textbooks series. The findings reveal that all CCSS for mathematics were covered by two of the three series, and additional learning expectations beyond the scope of CCSS were found in the textbooks. The implications are that all the expected outcomes of the CCSS may be covered by teachers, as they use learning materials to implement curriculum (Oates, 2014). However, the concern is the content in the textbooks which is beyond the scope of CCSS, which could well be taught by teachers, since they form part of the learning materials. It is critical for learning materials to cover expected content standards, and nothing else, since the purpose of the learning materials is to transform the intended content standards into the classroom (Porter, 2002). The findings obtained by the three studies are similar, since almost all the content standards are covered in the learning materials, even though not perfect (Hoadley & Galant, 2016; Polikoff, 2015; Tran, 2016).

A descriptive mixed methods study was conducted by Smith (2012) to evaluate the alignment of intended outcomes, curriculum materials and assessment with the use of Webb's (1997) alignment model. Curriculum materials with essential learning outcomes were analysed using Webb's (1997) alignment model, but omitted other elements that did not relate to the curriculum. Afterwards, data were tested for inter-rater reliability with the use of Fleiss's kappa co-efficient. The findings reveal that a number of curriculum materials are not adequately aligned to the learning outcomes. The implications of the misalignment are that, teaching and learning may not be linked to the content standards, since curriculum materials are used for teaching and learning (Gargiulo & Metcalf, 2017). The findings presented by Smith (2012) contradict the findings presented by Hoadley and Galant (2016), Polikoff (2015) and Tran (2016). This shows that some learning materials have been developed according to the content standards while others have not been designed accordingly.

Alignment between content standards and learning materials requires serious attention, since some teachers rely on textbooks for didactical knowledge and methodology to guide their instruction (Zmazek et al., 2012). So, if learning materials are misaligned to content standards, effective learning may be compromised, and the objectives of the curriculum may not be realised (Watty, Jackling, & Wilson, 2014). It is imperative for teachers to have an ability to spot quality learning materials, as different learning materials are being produced for the market. Alternatively, the DBE can provide guidance to schools on the quality learning materials during the process of requisition.

The literature on alignment studies between content standards and learning materials becomes significant for this study, as guidelines on the development of quality learning materials have been mentioned. At the same time, developers of learning materials should be aware of the prerequisite of linking learning materials with content standards (Watermeyer, 2012). This may help in alleviating the poor quality of learning materials in the classrooms. One can imagine the extent of damage that could be caused to the education system, if alignment studies are ignored between the educational components.

2.5. The Role of the Department of Basic Education Workbooks

The poor performance in numeracy and literacy prompted the Presidency and the DBE to commission the development of DBE workbooks, as part of the interventions aimed at improving performance in numeracy and literacy from Grade 1 to Grade 9 (DBE, 2013). Different names were attached to the Departmental workbooks, such as rainbow workbooks and DBE workbooks. However, the official name given by DBE is DBE workbooks. DBE workbooks for a particular grade and subject consist of two books designed to cover the content for two semesters: Book 1 and Book 2. Book 1 consists of assessment activities for Term 1 and Term 2, and Book 2 consists of assessment activities for Term 3 and Term 4. The implementation of DBE workbooks has been reported to have had a positive impact in the classroom setup (DBE, 2012). However, the big question is whether the DBE workbook activities are aligned to the content standards or not, which is the focus for this study. This is informed by the fact that no report was issued on the alignment of DBE workbook activities and content standards, except a study that focused on Grade 3 DBE workbooks (Hoadley & Galant, 2016).

The Australian Council for Educational Research (ACER) conducted an independent formative evaluation of textbooks and workbooks in South Africa. ACER (2013) highlights that DBE workbooks are intended to assist teachers and learners for the following objectives: (1) provision of worksheets; (2) activities to reinforce literacy and numeracy skills; (3) to monitor learners' performance; (4) the provision of easy to use lesson plans; and (5) to focus on curriculum delivery. Similarly, DBE workbooks could be used for practice, assessment, monitoring and teaching (Hoadley & Galant, 2016). On the other hand, Mathews et al. (2014) assert that workbooks are new resources that can become central for both teaching and learning. This is an indication that DBE workbooks are useful in the classroom. However, the lack of teachers' guides for the DBE workbooks remains a challenge for optimal usage of the resources (Hoadley & Galant, 2016).

ACER (2013) highlights that the purpose of DBE workbooks is twofold: (1) to contribute towards the improvement of quality and utilisation of workbooks and textbooks in South African schools; and (2) to provide feedback on the performance of language and mathematics workbooks in order to guide adjustments to editions in future. The findings indicate that 80% of the schools are using workbooks, and view them as daily effective tools. ACER (2013) further outline that some schools that are not using workbooks is because of non-delivery or late delivery. Yet, textbooks were found to be more aligned to learning goals and assessments than workbooks. This shows that content standards were taken into more careful consideration when developing textbooks than workbooks. All learning materials such as, textbooks, workbooks, study guides and many more should be aligned to content standards, as a prerequisite in developing learning materials (Watermeyer, 2012).

A qualitative study conducted by Mathews et al. (2014) used a case study design to analyse the use of workbooks in South African Grade 3 mathematics classrooms. The findings reveal that teachers do not use workbooks in ways that relate to DBE's intention. The researchers argue that training on the use of workbooks is a necessity, to enable teachers to implement the use of these resources effectively. This confirms the fact that special training on utilisation of workbooks is necessary. The findings from a study by ACER (2013) are similar to the findings presented by Mathews et al. (2014), since both indicate that DBE workbooks are being utilised by teachers, but not in line with DBE's recommendations. The DBE recommends that DBE workbooks be used with textbooks to save teachers from developing their own worksheets (DBE, 2013). Mathews et al. (2014) argue that mathematics resources can be supplemented by other resources in the classroom, as long as the purpose is for concept development.

Textbooks were found to play a critical role in lesson preparations, the selection of practice exercises and as a source for homework (Gracin & Matic, 2016). However, the use of mathematics learning materials and the supplement require teachers' capability to choose quality books. It is therefore important that teachers be equipped to spot quality learning materials with respect to alignment. This will help a great deal in making sure that quality learning materials are utilised in the classroom. This kind of empowerment could assist in alleviating poor learning materials in South African schools. And as a result, performance in mathematics would then improve as other researchers have proven to be possible (Biggs, 2014; Watermeyer, 2012). Hence, the literature on DBE workbooks is significant to this study, as the focus of this study is on, alignment between SPMCS and DBE workbook activities on NGP

2.6. Numeric and Geometric Patterns

In mathematics there are five main content areas, which include: numbers operations, and relationships; patterns, functions and algebra; space and shape; measurement; and data handling. The focus of this study is on NGP which is a topic under patterns, functions and algebra.

2.6.1. Numeric Patterns

Numeric patterns are patterns presented in the form of a sequence of numbers (Collocott, Dowse, Gerrard, & Maharaj, 2013). Research has revealed that patterning activities are a powerful tool for understanding functions and are an integral part of algebra (Beatty, 2014). However, learners are able to solve problems that involve symbols and procedures, but struggle to generalise patterns (Nurrahmi, Suryadi, & Fatimah, 2017). This is an indication that teachers should thoroughly and effectively teach the generalisation of patterns to enable learners to master algebra of higher order concepts. Patterns therefore form part of the basis of mastering algebra; hence, it is critical to understand and master them.

2.6.2. Geometric Patterns

Geometric patterns are numeric patterns represented diagrammatically (Collocott et al., 2013). Geometric patterns or visual patterns are part of algebra, and they are considered as a bridge to understanding sophisticated algebraic concepts (Barbosa & Vale, 2015). Pattern exploration helps one to formulate, justify and generalise patterns, and this later assists in developing conceptual construction of mathematical objects and easily attaching meaning to symbols, graphs and tables (Barbosa & Vale, 2015). This indicates that geometric patterns assist a great deal in understanding mathematics of a high order concepts. Table 2.1 below shows the intended concepts and skills to be achieved by senior phase learners on NGP.

Table 2. 1: Grade 7 to Grade 9 content standards on NGP (DBE, 2011, p. 21)

Grade 7	Grade 8	Grade 9
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers including patterns: • represented in physical or diagram form. • not limited to sequence involving a constant difference or ratio. • of learners' own creation. • represented in tables. 2. Describe and justify the general rules for observed relationships between numbers in own words.	1. Investigate and extend numeric and geometric patterns looking for relationships between numbers including patterns: • represented in physical or diagram form. • not limited to sequence involving a constant difference or ratio. • of learners' own creation. • represented in tables. • represented algebraically. 2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.	1. Investigate and extend numeric and geometric patterns looking for relationships between numbers including patterns: • represented in physical or diagram form. • not limited to sequence involving a constant difference or ratio. • of learners' own creation. • represented in tables. • represented algebraically. 2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.

Table 2.1 above shows the content standards which outline the concepts and skills to be achieved in the mathematics senior phase on NGP. The concepts and skills also indicate the progression of content from Grade 7 to Grade 9. In all the Grades: 7, 8 and 9 learners are expected to investigate and extend patterns, represented in diagrammatic form, sequence not limited to constant difference or constant ratio, of the learners' own creation and representation of patterns in tables. Again, learners are expected to describe the general rule of patterns in own words. However, the content progression in Grade 8 and Grade 9 expects learners to investigate and extend patterns represented algebraically, as well as describing the general rule of patterns in algebraic language. The progression in the content standards for different grades is discussed below.

In Grade 7, it is indicated that the justification of general rules should be described in own words and not in algebraic language. Contrary to that, algebraic language is mentioned under the Grade 7 teaching guidelines in CAPS. This error of commission in the teaching guidelines causes confusion to the teachers and developers of assessments and learning materials. In essence, teaching guidelines should be aligned with the intended content standards, in order to give guidance to all involved in teaching and the development of assessments and learning materials. However, in Grade 8 and Grade 9, algebraic language is recommended for the description and justification of general rules of patterns. This clarifies the content progression to which the concepts and skills on NGP for different grades in the senior phase should be. Some concepts were found to have been misplaced.

The teaching guidelines were found to have included the ranges of patterns to be taught in the senior phase mathematics on NGP. The inclusion of the ranges of patterns on the teaching guidelines is considered to be a key concept which users of the CAPS document might fail to notice. In Grade 7, the ranges of patterns outlined on the teaching guidelines and not mentioned on the content standards are the following: During Term 3, patterns should be restricted to using whole numbers, numbers in exponential form, common fractions and decimal fractions, but in Term 4, patterns can include integers.

This creates gaps since these important guidelines on developing assessments and learning materials might be missed by the users. In essence, teaching guidelines should provide clarity on the content standards, rather than adding new concepts. Again, in Grade 8, the range of patterns outlined under teaching guidelines include patterns with multiplication and division with integers. These ranges of patterns are not mentioned under the content standards. In Grade 9, learners are expected to consolidate what they have learnt in Grade 8. Given the progression of concepts and the ranges of patterns prescribed per grade, it is critical to align assessment activities for a grade with the ranges of patterns alluded to in CAPS.

DBE workbook activities are said to be aligned to content standards if they address the content of the same cognitive levels (Webb, 1997), to illustrate, if content standards require learners to investigate and extend numeric patterns with constant difference or constant ratio (DBE, 2011). The expectation from the DBE workbook activities is that, the assessment activities should also require learners to investigate and extend numeric patterns with constant difference or constant ratio. By so doing, the content standards and the assessment activities will be perfectly aligned, but, if the cognitive levels of the assessment activities and the content standards are not aligned, we therefore say that the two are misaligned.

It is important for the developers of learning materials and assessments to consult the CAPS document in order to verify the concepts and skills as well as the ranges of patterns to be considered for different grades and terms in a year. This will enable them to develop appropriate assessment activities and learning materials that are aligned to the content standards. The literature on NGP is very significant in making sure that teachers; and developers of learning materials and assessments realise the depth and breadth of NGP's concepts and skills as well as the importance of alignment. In Grade 7, it is expected that patterns in the third term will include (1) whole numbers, (2) numbers in exponential form, (3) common fractions, and (4) decimal fractions. And during the fourth term in Grade 7, the pattern should include integers. Table 2.2 below illustrates the prescribed range of patterns in Grade 7 from the researcher's patterns.

Table 2. 2: Illustration of Grade 7 ranges of patterns

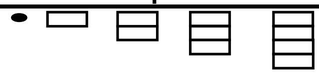
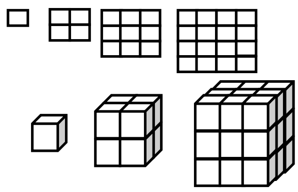
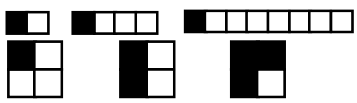
Type of pattern	**Numeric patterns**	**Geometric patterns**
Whole numbers	0; 1; 2; 3; 4; __; __; __	
Exponential form:	1^2; 2^2; 3^2; 4^2; __; __; __ 1^3; 2^3; 3^3; __; __; __	
Common fractions:	$\frac{1}{2}$; $\frac{1}{4}$; $\frac{1}{8}$; __; __; __ $\frac{1}{4}$; $\frac{2}{4}$; $\frac{3}{4}$; __; __; __	
Decimal fractions:	0,5; 0,25; 0,125; __; __; __ 0,75; 1,25; 1,75; __; __; __	
Integers	-5; -2; 1; 4; __; __; __ 81;31;-19;-69; __; __; __	

Table 2.2 above, shows the ranges of patterns prescribed in Grade 7. The table illustrates the ranges of patterns outlined on the teaching guidelines as well as the numeric and the geometric patterns. This was done to highlight how the numeric and geometric patterns would possibly look. It is advisable for developers of assessments and learning materials to consider the range of patterns prescribed in a grade or level when developing assessment activities. Other aspects to be considered when developing assessment activities are the concepts and skills to be demonstrated on NGP. These are clearly outlined in the CAPS document. So, it is critical to make sure that concepts and skills outlined on the content standards are the same as those that are expected to be demonstrate by the learners on assessments.

Biggs (2014) advises that the verbs outlined in the content standards should be reflected in the assessment activities. If the appropriate range of patterns for a grade are used, and the breadth and depth of skills prescribed on the content standards are measured on the assessments, we therefore say that the assessment is aligned to the content standards. These kinds of assessments are recommended since they assist in achieving the curriculum goals. Table 2.3 below shows the researcher's assessment examples on NGP for Grade 7 that are aligned to the content standards.

Table 2. 3: Grade 7 assessment activities aligned to the content standards

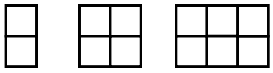
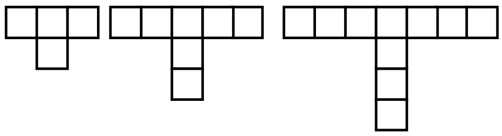
<table>
<tr><th>Concepts and skills</th><th>Assessment examples</th></tr>
<tr><td colspan="2">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td></tr>
<tr><td>• represented in physical or diagram form.</td><td>1. Investigate and extend the geometric patterns by three more terms.
 ___; _____; _____</td></tr>
<tr><td>• not limited to sequences involving a constant difference or ratio.</td><td>3. Investigate and extend numeric and geometric patterns by three more terms.
• 5; 9; 13; ___; ____; ___
• 2; 4; 8; 16; ___; ___; ___
• 4; 9; 16; 25; ___; ___; ___
 _; _; _</td></tr>
<tr><td>• of learner’s own creation.</td><td>4. Investigate and extend numeric patterns of your own creation.
• Where the common difference is 3.
• Where the pattern starts from 10 and decrease by 6.</td></tr>
<tr><td>• represented in tables.</td><td>5. Investigate and extend the numeric patterns by three more times.<table><tr><td>Position of the term</td><td>1</td><td>2</td><td>3</td><td>5</td><td>9</td><td>15</td></tr><tr><td>Value of the term</td><td>8</td><td>15</td><td>22</td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>2. Describe and justify the general rules for observed relationships between numbers in own words.</td><td>6. Describe the following patterns in own words.
• 46; 57; 68; 79; __
• 1; 8; 27; 64; __
7. Given the sequence: 33; 44; 55; __
• Will the general rule be add 10 or add 11? Justify your general rule in your own words.</td></tr>
</table>

Table 2.3 above shows Grade 7 assessment activities that are cognitively aligned to the content standards. This was aimed at revealing the kind of assessment activities expected to be achieved in Grade 7. This kind of conclusion can only be made if the range of patterns for a grade and the concepts and skills expected to be achieved by the learners have been measured on the assessment activities. Teachers and developers of assessment tasks and learning materials are encouraged to verify the ranges of patterns for a grade as well as the concepts and skills to be covered from the content standards. These may contribute to the quality of assessments and learning materials, since assessment should be cognitively aligned to the content standards. The ranges of number patterns in Grade 8 are extended to include patterns with multiplication and division with

integers. Table 2.4 below shows the researcher's own patterns that are extended in Grade 8.

Table 2. 4: The extended patterns in Grade 8

Type of pattern	**Numeric pattern**
Multiplication with integers	3x4; 6x4; 9x4;...
Division with integers	$\frac{4}{-2}; \frac{8}{-2}; \frac{12}{-2}; \frac{16}{-2}; \ldots$

Table 2.4 above shows the ranges of patterns expected to be extended in Grade 8 which are: patterns involving multiplication with integers as well as division with integers. Under investigation and extension of NGP, patterns represented algebraically were also added in Grade 8. This means that patterns involving algebraic language should also be investigated and extended, looking for a relationship. Table 2.5 below shows researcher's own examples of the patterns represented in algebraic language.

Table 2. 5: Assessment activities involving algebraic language

<table>
<tr><th>Concepts and skills</th><th>Assessment activities</th></tr>
<tr><td colspan="2">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td></tr>
<tr><td>• represented algebraically.</td><td>1. Use the algebraic expression to extend the numeric pattern.
$y = 5x + 2$<table><tr><td>x</td><td>1</td><td>2</td><td>3</td><td>7</td><td>12</td></tr><tr><td>y</td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.</td><td>2. Describe the general rule of the following pattern in own words and write the rule in algebraic language.
4; 9; 16; ...</td></tr>
</table>

Table 2.5 above shows the extended concepts and skills and their assessment examples for Grade 8. The following have been extended: the investigation and extension of patterns represented algebraically, as well as describing and justifying general rule of patterns in algebraic language. It is important to check the concepts and skills on the CAPS document in order to verify the ranges of number patterns to be covered. This may help in setting appropriate assessments that are cognitively aligned to the content standards. Furthermore, Grade 9

concepts and skills were found to be the same with Grade 8, however, learners are expected to consolidate what they have learnt in Grade 8.

2.7. Mathematics Cognitive Levels

Different cognitive levels were developed with different categories for various purposes. Cognitive levels distinguish the level of understanding and they determine the appropriate depth of the understanding (Zhuge, 2016). In simpler terms, cognitive levels categorise assessment activities into different ranges of difficulty, from the low level of difficulty to a high level of difficulty. The taxonomies can be used to classify assessment activities in terms of low order and high order. Also, taxonomies are used in this study to code assessment activities in terms of their depth of understanding. Different researchers have used different taxonomies, but the most commonly used taxonomies are: The Bloom taxonomy and its revised version; the Marzano and Kendall taxonomy; and TIMSS taxonomy. These taxonomies are discussed below.

2.7.1. Bloom's Taxonomy

According to Bloom (1956) taxonomy contain six categories of cognitive levels from low order to high order, namely; knowledge, comprehension, application, analysis, synthesis and evaluation. Categories of cognitive levels for Bloom were revised and the order of categories was also changed with addition of the following categories: remembering, understanding, applying, analysing, evaluating, and creating.

2.7.2. The Marzano and Kendall Taxonomy

Another taxonomy that researchers employ, is the Marzano and Kendall taxonomy. Marzano and Kendall (2006) contain six categories of cognitive levels, namely, retrieval, comprehension, analysis and knowledge utilisation, metacognition and self-system thinking. This taxonomy was developed with the hope that it would address shortcomings identified in Bloom's taxonomy.

2.7.3. The TIMSS Taxonomy

The TIMSS as an international framework also developed cognitive levels, which were revised from time to time. The South African curriculum has adopted the 1999 TIMSS cognitive levels which are also recommended for assessment purposes in mathematics. Hence, the researcher employed the 1999 TIMSS's cognitive levels in this study in order to concur with the CAPS, as it is used for everyday teaching and assessments. The 1999 TIMSS's cognitive levels are categorised into four, namely; knowledge, routine procedures, complex procedures and problem solving, and they contribute 25%, 45%, 20% and 10% respectively (DBE, 2011). These percentages are used to set a standardised formal assessment task.

The three taxonomies address different dimensions. The Bloom taxonomy focuses only on cognitive domain, while the Marzano and Kendall taxonomy deals with three systems as well as adding metacognition and self-system thinking (Irvine, 2017). The revised Bloom taxonomy does not address the aspect of problem solving. The problem with revised Bloom taxonomy; and Marzano and Kendell taxonomy is of presenting a linear theory of learning while many theories exist in learning (Irvine, 2017). Marzano and Kendall (2006) assert that their taxonomy deals with human thought. Bloom (1956) emphasise that his theory is for learning, teaching and assessment. TIMSS taxonomy became outstanding, because it consists of cognitive component, content component as well as addressing problem solving as a key element of learning (Long, & Dunne, 2014). The TIMSS taxonomy was chosen because of its comprehensive components and the fact that the South African curriculum has adopted it for assessment and teaching purposes. The researcher did not want to deviate from the well-used taxonomy of the South African curriculum, and more so that the study deals with content and cognitive component which are the components of TIMSS taxonomy.

The TIMSS taxonomy comprises of the following categories: knowledge, routine procedures, complex procedures, and problem solving. DBE (2011) states that ‘knowledge’ are straight recall questions which directly use a formula. Adams (2015) describe knowledge questions as foundational cognitive skill, and deals with retention of specific, discrete pieces of information like facts and definitions. It is important to note that different cognitive levels address different skills and understanding which also specify the depth of the concepts (Long & Dunne, 2014).

In addition, ‘routine procedures’ are questions that need simple applications and steps (DBE, 2011). Kalobo and Toit (2015) describe ‘routine procedures’ as being the cognitive level that goes beyond facts and simple recall, where learners carry out steps in a procedure. Actually, this cognitive level involves straight-forward steps to solve a problem. Different procedures are used to arrive at the same solution. DBE (2011) highlights that ‘complex procedures’ are questions that involve complex calculations and have no obvious roads to solutions. Similarly, Kalobo and Toit (2015) claim that ‘complex procedures’ involve unfamiliar problems or abstract problems that do not have a direct route to the solution.

Kalobo and Toit (2015) further assert that ‘problem solving’ refers to unseen problems that require a higher level of cognitive skills and reasoning to solve problems. The researcher’s view is that the depth and breadth of content standards should be directly proportional to the breadth and depth of the assessments, instruction and learning materials. Assessment can be used as a bridge between teaching and assessment, since is used to check whether intended instructional activities have been achieved (Msimango, 2017). This will help learners to perform better on their assessments, since they will be engaged on the same levels of difficulty on instruction, assessment and learning materials (Porter, 2002). Alignment prevails when content standards are cognitively aligned to assessment, content standards to instruction, and assessment to instruction (Davis-Becker & Buckendahl, 2013).

Assaly and Smadi (2015) conducted a study to evaluate the cognitive levels of the questions posed on the reading texts of the Master class textbook. The findings reveal that the Master class textbook has included more comprehension questions but has neglected knowledge and application questions. This shows that the weighting of cognitive levels is not covered according to the curriculum expectations. It is important to cognitively align assessment activities with the content standards to ascertain the weightings of cognitive levels prescribed in the CAPS document (Webb, 2007). The findings of the study are similar to the findings of the study by Smith (2012), where learning materials are not aligned to the content standards. This creates gaps within the depth and the breadth of knowledge in relation to those cognitive levels intended to be achieved (Scheerens, 2016). Cognitive levels play a critical role in differentiating the level of difficulty of the assessment activities. Hence, the literature on cognitive levels is very significant to this study, as the importance of cognitive levels is discussed in details, which may help to improve the development of assessments and learning materials in future.

2.8. Synthesis of Literature

The alignment procedures, where models of alignment were discussed to illuminate the alignment models. The alignment models used to explore alignment between content standards and assessment were also highlighted, which are: Achieve, Porter (2002) and Webb (1997). Thereafter, alignment between different educational components in relation to this study was explored in order to provide appropriate guidance to this study. In addition, the positive aspects and the implications of alignment studies in relation to the components were reviewed in order to address the gaps in future. The alignment studies investigated the status of alignment between the following components: content standards, assessment and learning materials. Similarities that can be drawn from the alignment studies are that: they all emphasise the importance of aligning educational components to help improve the quality of the education system.

Over and above that, the findings highlight different degrees of alignment; other components are significantly aligned while others are misaligned. The literature indicates that, at times, content standards are considered when developing assessments and learning materials, while others do not consider them at all, which is a serious challenge that needs to be addressed. Furthermore, developers of assessments and authors of learning materials should consider alignment with content standards to be prerequisite in developing any educational learning materials and assessments (Watermeyer, 2012).

The issue of aligning learning materials with content standards cannot be over emphasised. The DBE workbooks, as one of the learning materials, were also discussed as the focus of this study. Even though the role of DBE workbooks is to supplement teachers' resources with worksheets, it is insisted that they too should be aligned to the content standards, as some teachers use them for teaching and learning (Mathews et al., 2014). This study did not focus on the whole content of the DBE workbooks, but rather on the section dealing with NGP.

The literature on NGP was also reviewed, which indicated that the patterns and generalisation of patterns assist a great deal in learning algebraic concepts of high order. This makes the topic on patterns critical in forming the basis of learning algebraic concepts of higher order. Hence, it is critical for teachers to understand and be able to teach patterns effectively. The literature on cognitive levels was also reviewed, where the three commonly used taxonomies were discussed, which are: the Bloom, Marzano and Kendell and TIMSS taxonomy. Out of the three taxonomies, TIMSS became outstanding, since it comprises of content component and cognitive component, while others have one component. TIMSS also addresses the issue of problem solving as being the critical element for learning to take place. The researcher is of the view that the dimensions employed in reviewing the literature may represent a positive contribution in guiding this study appropriately.

2.9. Theoretical Framework

The theoretical framework guiding this study is twofold. It consists of two alignment models: (1) Webb (1997), and (2) Porter (2002).

2.9.1. The Webb's (1997) alignment model

A qualitative document analysis of SPMCS and DBE workbook activities on NGP was done through the use of Webb's (1997) alignment model, to give the status of alignment in terms of their content structure. Webb recommends six main criteria of content focus to judge alignment between content standards and assessment, namely: (1) categorical concurrence; (2) depth of knowledge consistency; (3) range of knowledge correspondence; (4) structure of knowledge comparability; (5) balance of representation; and (6) dispositional consonance.

However, this study adopted the three Webb's criteria of content focus to explore alignment between SPMCS and DBE workbook activities on NGP. The criteria of content focus employed were categorical concurrence, depth of knowledge consistency and range of knowledge correspondence. The exclusion of balance of representation was because the criterion spell out the amount of weighting of content in both content standards and assessment. Unfortunately, the weighting of content is done in terms of the content areas and the weighting of topics is measured in terms of the time allocation for the topic. This study focused on the topic which is measured in terms of time allocation, which is not the focus of this study. This study focused on exploring alignment between SPMCS and DBE workbook activities on NGP in terms of the content and not time allocation. The exclusion of structure of knowledge comparability is because it focuses on how learners draw connections from different ideas, and is not the focus of this study. Dispositional consonance was also excluded because of its focus on learners' attitudes and beliefs, while this study seeks to explore alignment in terms of content, rather than norms and values. The selected Webb's criteria of content focus illuminated how SPMCS and the DBE workbook activities on NGP have been structured to expose the status of alignment. The researcher also adopted Porter's (2002) alignment model to calculate alignment indices, since it deals with the calculation of alignment indices comprehensibly in simpler terms. Porter (2002) has been identified as the most effective and simplest model to explore alignment indices between content standards and assessment (Ndlovu & Mji, 2012).

Hence, this study employed Webb (1997) to generate and analyse qualitative data in order to explore alignment in terms of the content structure, and Porter (2002) for quantitative data, to explore alignment in terms of the alignment indices. The researcher is of the view that exploring the two dimensions of alignment, which are in terms of content structure and alignment indices, may help in achieving the comprehensive outcomes of this study. The three Webb's criteria of content focus are explored below.

❖ CATEGORICAL CONCURRENCE

The first category, categorical concurrence, was used to judge the general alignment status between the content standards and assessment through verification of consistency of content between them (Webb, 1997). In actual fact, the categorical concurrence gives clarity on whether the assessment measured the content from the content standards (Webb, 2007). The categorical concurrence was explored qualitatively. The qualitative document analysis of categorical concurrence compared and verified the depth of the consistency of content on both SPMCS and DBE workbook activities on NGP. The content analysts mapped the content standards with the cognitive levels. The same process was employed on DBE workbook activities on NGP, where assessment activities were mapped with the cognitive levels.

The qualitative data focused on verifying and comparing the results based on the content covered by the two components, with special emphasis on areas of consistency and commonality. This was done to establish whether the DBE workbook activities on NGP measured content of the content standards. Assessment activities that assessed content beyond the scope of the content standards were identified and highlighted.

The units of comparison for this category were content covered on the content standards and DBE workbook activities on NGP. The scale of agreement included 'full', 'acceptable' and 'insufficient', where 'full' level of agreement was applicable where there was one-to-one correspondence between content standards and assessment activities. On the other hand, 'acceptable' level of agreement was applicable where assessment activities had covered nearly all the content standards. The 'insufficient' level of agreement was applied where the exclusion of important content standards existed.

This category on categorical concurrence was explored to verify if the content on SPMCS was consistent with the DBE workbook activities. What was critical was the coherence of content between the two components. Polikoff and Porter (2014) supports the idea that assessment should cover all the concepts and skills detailed on the content standards. Polikoff and Porter (2014) trust that this is aimed at reinforcing the content message prescribed on the content standards, and further provide evidence of learners' mastery of the content. In essence, assessment must cover the full range of concepts and skills prescribed on the content standards to enhance the quality of the education system (Polikoff & Porter, 2014; Porter, 2002; Webb, 1997). The following category on the depth of knowledge consistency is discussed.

- DEPTH OF KNOWLEDGE CONSISTENCY

The second category, depth of knowledge consistency, refers to the identification of cognitive level in both content standards and assessment activities (Karuguti, Phillips, & Barr, 2017). Cognitive level is described as being the depth of knowledge, it distinguishes the levels of knowledge understanding (Zhuge, 2016). Cognitive levels assist in categorising assessment activities into different levels of cognitive levels. As such, activities can be classified into low level, moderate level and high level of difficulty. Morrison and Embretson (2014) claim that mathematics assessment activities should indicate specific mathematical skills in order to show the variation of cognitive level. This means that the cognitive levels of the assessment activities should clearly indicate the type of skills to be demonstrated by learners.

The analysis of cognitive levels of the mathematics assessment activities became important in guiding this study appropriately. Hsu and Silver (2014) assert that highlighting cognitive levels as key points during instruction can assist learners to differentiate the cognitive levels of the assessment activities. Webb (1997) highlights that cognitive levels have been categorised into four levels: Level 1 (recall), level 2 (skill/concepts), level 3 (strategic thinking) and level 4 (extended thinking). First, level 1 deals with recall items such as fact, and definition, as well as performing a simple procedure. Second, level 2 deals with skill or concept item, it engages a mental processing by allowing learners to choose operation or method to get to the solution. Third, level 3 deals with strategic thinking items that require learners to reason and come with strategies to get to the solution. Last, level 4 deals with extended thinking items which require a high level of reasoning and planning to be extended for some time before engaging on the item.

The 1999 TIMSS's cognitive levels which also correspond to the Webb's cognitive levels have been described as follows: Adams (2015) describes cognitive level 'knowledge' as foundational cognitive skill and deals with retention of specific, discrete pieces of information like facts and definitions. Kalobo and Toit (2015) describe 'routine procedures' as a cognitive level where learners carry out simple procedures which involve steps, such as solving equations. Kalobo and Toit (2015) describe 'complex procedures' as abstract problems that do not have obvious route to the solution. Here learners are expected to use concepts to solve problems.

Lastly, DBE (2011) describes ‘problem solving’ as unseen, non-routine problems that require higher level of cognitive skills and reasoning to solve problems. The problem might require an ability to break down the problem into manageable parts. For the sake of aligning this study with the cognitive levels recommended by the DBE, the researcher employed the TIMSS’s cognitive levels to analyse the cognitive levels of the SPMCS and DBE workbook activities on NGP. The analysis of DoK consistency was done qualitatively. The qualitative analysis focused on identifying and comparing cognitive levels covered on the SPMCS and DBE workbook activities on NGP. This was done to see whether the content covered by the two components has measured the same cognitive levels. The following category on the range of knowledge correspondence is discussed.

❖ RANGE OF KNOWLEDGE CORRESPONDENCE

The third category, range of knowledge correspondence, is the breadth coverage of content (Troia, Olinghouse, Wilson, Stewart, Mo, Hawkins, & Kopke, 2016). The breadth coverage of content outline the wide range or scope of content to be covered rather than the depth of content which is more detailed (Jonhson, 2016). The breadth coverage of content therefore outlined the wide range of concepts (what learners should know) and the type of content. For content standards to be aligned with assessment activities, their breadth of knowledge should correspond (Webb, 1997). Webb highlights that, when analysing the range of knowledge correspondence, the criterion is through mapping the breadth of content for the content standards with the assessment activities. The units of comparison included the ranges of patterns for the assessment activities and the content standards. The scale of agreement, on this particular criteria, included ‘full’, ‘acceptable’ and ‘insufficient’. Along with, ‘full’ level of agreement, it was applied when full range of patterns on content standards was covered by the assessment activities. Furthermore, ‘acceptable’ level of agreement was applied where nearly all the ranges of patterns for content standards were covered by the assessment activities. In addition, the level of agreement, ‘insufficient’ was applied when the major concepts on the content standards were excluded on the assessment activities.

This study employed this category to determine the ranges of patterns covered in both SPMCS and DBE workbook activities on NGP, and to explore their alignment status in terms of the content structure. The next item to be discussed is the Porter's alignment model.

2.9.2. The Porter's (2002) alignment model

Porter's (2002) alignment model was employed to calculate alignment indices between SPMCS and DBE workbook activities on NGP. Porter emphasises the alignment between content of instruction, educational materials, content standards, assessment and professional development. However, this study focused on the alignment between SPMCS and DBE workbook activities on NGP. Porter uses alignment index to describe alignment and also provides a quantitative test for coherence between educational components such as content standards, instruction, and assessment (Porter, 2002).

In addition, Porter (2002) recommends two content matrices to compare cell-by-cell proportions. One content matrix for the content covers topic-by-cognitive level, and the other assessment matrix covers assessment-by-cognitive level. The proportions for the two matrices are then used to calculate the alignment indices. The researcher would have opted for Webb (1997) to calculate alignment indices, but realising that Porter (2002) is the simplest and effective alignment model that uses two variables, the researcher then opted for Porter. In developing the matrices, the matrix for content contained content, as mentioned in the CAPS document, and the cognitive levels adopted by the researcher, which are from the 1999 TIMSS as recommended by CAPS. The alignment index was then calculated using the Porter's alignment index below.

$$\text{Alignment index} = 1 - \frac{\sum|x - y|}{2}$$

where x denotes the cell proportions in the content matrix and y denotes the cell proportions in the assessment matrix.

Furthermore, the alignment models of Webb (1997) and of Porter (2002) emphasise that content standards and assessment should be cognitively aligned. Consequently, this study employed Porter's (2002) alignment model to calculate alignment indices and Webb (1997) to explore alignment in terms of the content structure between SPMCS and DBE workbook activities on NGP. The following chapter focused on the methodology employed in this study.

3. CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Introduction

This chapter starts by highlighting the educational research approaches and justifying why mixed methods research was adopted. This chapter also outlines the research designs under mixed methods research and justifies why exploratory sequential design was selected. Methods of data collection, data analysis and their related ethical issues are highlighted in this chapter. This was done to clarify how this study was conducted. Moreover, the selection of the appropriate research methods is strongly encouraged in order to produce comprehensive results (Khusainova, Shilova, & Curteva, 2016).

3.2. Research Approach

Fundamentally, there are three major empirical research approaches, namely: qualitative research, quantitative research and mixed methods research (Creswell & Creswell, 2017). The empirical research approaches are explored below: Firstly, qualitative research is applicable when one wants to understand the phenomenon that cannot be measured quantitatively such as human experiences, culture, beliefs and values (Kalu & Bwalya, 2017). Kalu and Bwalya (2017) further state that trustworthiness of qualitative research is often questioned, and for that reason, transparency and accountability in all the research processes are highly recommended. Secondly, quantitative research refers to empirical investigations that involve statistical or computational techniques (Bernard & Bernard, 2013). The findings in quantitative research are usually generalised, hence the sample should be representative of the entire population (Bryman, 2016).

Thirdly, mixed methods research is defined as an approach to research where both quantitative data and qualitative data are employed in a research in order to understand the research problem (Creswell, 2015). Consequently, the research approach employed in this study was the mixed methods research. The mixed methods research was more valuable than a singular method research to achieve the purpose of this study effectively (McKim, 2017). The choice of employing the mixed methods was guided by Ngulube and Ngulube (2015), who claim that the mixed methods provide the following benefits: (1) a better balance in different approaches to a research problem; (2) the possibility of enhancing the comprehensiveness of the results on the phenomenon under exploration; and (3) help to achieve the research purpose effectively.

Johnson and Christensen (2008) assert that mixed methods research contributes to achieving a study of quality and achieving multiple validities and legitimation. The mixed methods research played a pivotal role in answering the research questions. The use of the mixed methods research benefited this study through exploring different data types which consequently produced comprehensive results to answer the following research question: 'To what extent are the senior phase mathematics content standards aligned with the Department of Basic Education workbook activities on numeric and geometric patterns'?.

3.3. Research Design

There are many designs in mixed methods research. According to Creswell, Plano Clark, Gutmann and Hanson (2003), mixed methods designs are classified into two major categories: sequential and concurrent. The three types of sequential mixed methods design are: (1) sequential explanatory, (2) sequential exploratory and (3) sequential transformative. The sequential explanatory design is a research design where the researcher conducts qualitative research first, then builds on the results for a detailed explanation with the use of quantitative research (Creswell & Clark, 2017). The sequential exploratory design, allows the researcher to first collect data and explore results in the qualitative phase. This later builds into the quantitative phase with the aim of testing, corroborating or generalising the initial findings (Creswell & Clark, 2017; Bishop & Holmes, 2013).

The sequential transformative design also has two phases of collecting data: quantitative and qualitative, any method maybe used first, and results are integrated in the interpretation phase (Creswell et al., 2003).

The three types of concurrent mixed methods designs are: (1) concurrent triangulation, (2) concurrent nested and (3) concurrent transformative (Creswell et al., 2003). In concurrent triangulation design data collection is concurrent and is used to confirm, validate or corroborate findings (Creswell & Clark, 2017). Concurrent nested design include one phase of data collection where priority is given to one approach that guides the research project, while the other approach is nested and take the supporting role (Creswell & Clark, 2017). On the other hand, concurrent transformative design guides the methodological choices and is used to evaluate theoretical perspectives at different levels of analysis (Creswell et al., 2003).

The exploratory sequential design was useful in this study, since only limited knowledge about the alignment between SPMCS and DBE workbook activities on NGP was found (Beyene, 2016). The exploratory sequential design aimed at exploring more about the research problem of teachers using DBE workbooks for teaching and learning, while their alignment status was not confirmed through an alignment study (Ponce & Pagan-Maldonaldo, 2015)

Nevertheless, this study focused on exploring the alignment between SPMCS and DBE workbook activities on NGP through employing the qualitative phase followed by the quantitative phase. This was done to corroborate the qualitative data, and the quantitative data rather than generalising nor developing instruments. This study explored both qualitative phase and quantitative phase in order to form a basis for future researches, since little literature was discovered on alignment between SPMCS and DBE workbook activities, to illustrate, a study conducted by Hoadley and Galant (2016). The exploratory sequential design was the most appropriate, since this study generated and analysed qualitative data by mapping SPMCS and DBE workbook activities with the use of Webb's (1997) criteria of content focus. Again, quantitative data was generated through mapping SPMCS and DBE workbook activities with the use of Porter's (2002) alignment model. SPMCS contain the content and skills to be achieve in the mathematics senior phase, while DBE workbook activities contain assessment activities. Webb alignment model was used to generate qualitative data to explore alignment in terms of the content structure. Subsequently, quantitative data were generated using Porter's alignment model to explore alignment in terms of the alignment indices. The two alignment models were applied sequentially.

As guided by exploratory sequential design, the sequence of collecting and analysing data proceeded from the qualitative phase building into the quantitative phase (Creswell & Clark, 2017). The sequence had two parts. Part one was used to collect and analyse the qualitative data to explore alignment in terms of the content structure between SPMCS and DBE workbook activities on NGP. Thereafter, part two was used to collect and analyse the quantitative data to explore alignment in terms of the alignment indices. Consequently, the results from the two sequential parts were corroborated to produce comprehensive results. The exploratory sequential design contributed in this study to explore both qualitative phase and quantitative phase in order to complement the findings from both phases. This was done to capture different viewpoints or perspectives. Details of the researcher's research design are in Table 3.1 below.

Table 3. 1: Researcher's exploratory sequential design

Researcher's exploratory sequential design								
Qualitative		**Qualitative**		**Quantitative**		**Quantitative**		
Part 1 phase 1 Data collection		**Part 1 phase 2 Data analysis**		**Part 2 phase 1 Data collection**		**Part 2 phase 2 Data analysis**		
Generated and collected qualitative data by mapping SPMCS and DBE workbook activities on NGP according to Webb's (1997) criteria of content focus to explore content structure in terms of categorical concurrence, depth of knowledge consistency and range of knowledge correspondence.	⟹ built to ⟹	Analysed qualitative data through counting and verifying the highest consistency and commonality of content between content analysts' content analysts' coding as well as calculating Krippendorff alpha to measure agreements and disagreements between content analysts to examine the categorical concurrence, depth of knowledge consistency and range of knowledge correspondence.	⟹ built to qualitative data results	Generated and collected quantitative data through mapping SPMCS and DBE workbook activities on NGP matrices with cognitive levels using Porter's (2002) alignment model to examine alignment indices	⟹ built to ⟹	Analysed quantitative data focusing on cognitive score points, total content proportions, proportions grand total, alignment indices and discrepancies to examine the degree of alignment indices	⟹ built to qualitative data results ⟹	Interpretation of qualitative and quantitative results

Table 3.1 above shows the researcher's exploratory sequential design selected for this study. It outlines the parts and the phases employed in the research design. The collection of data and analysis of data were done sequentially. Qualitative data were collected and analysed first, then later quantitative data were collected and analysed. Consequently, the results from the two set of data were corroborated.

3.3.1. Sampling

There are two major categories of sampling; probability, where all participants have equal chance to be sampled, and non-probability sampling, where participants do not have equal opportunities to be part of the sample (Elfil &

Negida, 2017). This study sought to align SPMCS and DBE workbook activities on NPG, and so documents were selected for analysis. O'Leary (2017) states that there are three types of documents: (1) public records, (2) personal documents, and (3) physical evidence. Public records are official records including policy manuals, strategic plans, syllabi and many more, while personal documents include calendars, email, Facebook posts and newspapers (O'Leary, 2017). Physical evidence are artefacts that are found in a study setting such as training manuals, flyers, posters, agenda and many more (Stroker & Evans, 2016). This study focused on analysing public documents in two categories: educational policies and DBE workbooks. Details of sampling are discussed in the subsequent sub-topics below.

❖ SAMPLING PROCEDURE

Four documents were selected for document analysis. In selecting a sample of documents, purposive sampling was deliberately employed to reach the targeted sample quickly, in order to address the research purpose. Purposive sampling was guided by the research purpose, which was to explore the alignment between SPMCS and DBE workbook activities on NGP (Bryman, 2016). Purposive sampling is a non-probability sampling technique that deliberately selects participants according to their qualities in relation to the study (Etikan, Musa, & Alkassim, 2016).

❖ SAMPLE

The documents sampled included: (1) Department of Basic Education-Curriculum and Assessment Policy Statement, Grades 7-9 Mathematics, published in 2011; (2) Department of Basic Education Workbook, Grade 7 Mathematics in English Book 2, published in 2017; (3) Department of Basic Education Workbook, Grade 8 Mathematics in English Book 1, published in 2017; and (4) Department of Basic Education Workbook, Grade 9 Mathematics in English Book 1, published in 2017. However, this study focused on NGP as a selected topic under SPMCS from the CAPS document and NGP assessment activities in the mathematics DBE workbooks for Grade 7 to Grade 9. Basically, the DBE designed two workbooks to cover annual assessment activities for different subjects. These are: Book 1 and Book 2. Book 1 covers all assessment activities for Term 1 and Term 2, while Book 2 covers assessment activities for Term 3 and Term 4. So, different workbooks were sampled based on the availability of NGP's content. The numbers of worksheets sampled on DBE workbook activities on NGP were 13, 2 and 2 for Grade 7, Grade 8 and Grade 9 respectively. The number of assessment activities sampled from DBE workbooks for content analysis in Grade 7, Grade 8 and Grade 9 were 27, 12 and 7 respectively. Many worksheets and assessment activities were sampled in Grade 7 than in Grade 8 and Grade 9. This is because the topic on NGP was covered in two terms in Grade 7: Term 3 and Term 4, while in Grade 8 and Grade 9 the topic was covered only in one term: Term 1. Hence, Grade 7 had many worksheets and assessment activities. Related assessment activities were grouped together to avoid repetition.

3.3.2. Data Collection

Since the study used mixed methods research, both qualitative data and quantitative data were collected for triangulation paradigm purposes. Qualitative research and quantitative research approaches were employed to capture different viewpoints of the research problem. This was done to gain an understanding from different perspectives. The researcher used the expertise of subject advisors in the field of mathematics to serve as content analysts to collect data. Details of data collection are discussed in the subsequent sub-topics below.

- ❖ DATA COLLECTION APPROACH AND METHOD

The appropriate data collection method was critically employed in this study (Phillips & Stawarski, 2016). Data was constructed by subject advisors who served as content analysts. Content analysts mapped the SPMCS and DBE workbook activities with Webb's criteria of content focus and cognitive levels. Content analysis was employed as research method for this study. Content analysis is described as being the detailed examination of contents with the purpose of identifying themes and patterns (Leedy & Ormrod, 2013). Furthermore, data collection was employed in two phases: the qualitative phase and the quantitative phase. Data was obtained mainly by analysing documents.

Data was collected in two phases. In phase one, qualitative data was constructed by content analysts on the sampled documents: senior phase mathematics CAPS document, Grade 7 mathematics DBE workbook 2, Grade 8 mathematics DBE workbook 1 and Grade 9 mathematics DBE workbook 1. Qualitative data was constructed through employing the Webb's (1997) criteria of content focus to explore alignment in terms of the content structure. In phase two, quantitative data was constructed through analysing same documents as in qualitative data to explore alignment in terms of alignment indices using Porter's (2002) alignment model.

Mapping of content by the content analysts on qualitative data was done independently, while a common framework was used in mapping quantitative data. The trustworthiness of data collected by the content analysts was ensured by employing Krippendorff alpha, to measure agreement and disagreement among the content analysts (Zapf, Castell, Morawietz, & Karch, 2016). The content analysts were subject advisors for mathematics in the senior phase; people who are knowledgeable in the focus area of this study. The training of the content analysts was conducted by one of the supervisors in the field of research to establish a common understanding in terms of mapping content.

This study had two sub-research questions to answer:

(1) What content structure do the senior phase mathematics and Department of Basic Education workbook activities on numeric and geometric patterns have?

(2) How do the senior phase mathematics content standards align with the Department of Basic Education workbook activities in the numeric and geometric patterns' content standards?

The researcher used the qualitative data to answer the first research sub-question to clarify the content structure between SPMCS and DBE workbook activities on NGP. The quantitative data was used to answer the second research sub-question in order to clarify how the SPMCS and DBE workbook activities align, using calculated alignment indices.

❖ DEVELOPMENT AND TESTING OF THE DATA COLLECTION INSTRUMENT

Both qualitative and quantitative instruments for data collection were developed on Excel spreadsheets to be able to work with calculations at ease. Qualitative data collection matrices were adopted from Webb (**See Appendices: G1, G2, G3, H1, H2, H3, I1, I2, I3, J1, J2, J3, K1, K2, K3, L1, L2 and L3)** and quantitative data collection matrices were adopted from Porter (**See Appendices: M1, M2, M3, N1, N2 and N3)** to collect different data types for theory triangulation purpose. Furthermore, two matrices were developed to consolidate the quantitative data for effective data analysis (**See Appendices: O and P**).

❖ CHARACTERISTICS OF THE DATA COLLECTION INSTRUMENT

Eighteen qualitative data collection instruments were developed following the three categories of Webb's (1997) criteria of content focus. From the eighteen qualitative data collection instruments, six were for Grade 7, Grade 8 and Grade 9 categorical concurrence, where three focused on content standards for the three grades, and the other three focused on DBE workbook activities for the three grades. Another six from the eighteen were for Grade 7, Grade 8 and Grade 9 DoK consistency, where three were for the content standards for the three grades, and the other three were for the DBE workbook activities for the three grades. Another six to make them eighteen were for the range of knowledge correspondence for Grade 7, Grade 8 and Grade 9, where three were for the content standards and the other three were for the DBE workbook activities on NGP.

In addition, eight quantitative data collection instruments were developed following Porter's (2002) alignment model. From the eight quantitative data collection instruments, three were content matrices for Grade 7, Grade 8 and Grade 9. The other three were for assessment matrices for Grade 7, Grade 8 and Grade 9. The last two quantitative data collection instrument were used to summarise data on content proportions and assessment proportions. These eight instruments were used to calculate the alignment indices between SPMCS and DBE workbook activities on NGP.

- DATA COLLECTION PROCESS

The expertise of four content analysts was used to construct data through mapping the content for both qualitative data and quantitative data. The researcher requested one of the supervisors in the field of research to train the content analysts in the process of mapping content. On qualitative data collection, the content analysts mapped the content independently. In addition, mapping content on categorical concurrence focused on identifying the content covered on the content standards and the DBE workbook activities on NGP (**See Appendices: G1, G2, G3, H1, H2 and H3**). Each content analyst identified the content covered on the content standards as well as the content covered on the DBE workbook activities on NGP. Related assessment activities were grouped together to avoid repetition. Summaries of worksheets, problem solving activities and sharing activities were abbreviated as WS, PS and S respectively. This was done for efficient data collection.

Furthermore, mapping content on the DoK consistency was based on mapping the content standards and the DBE workbook activities with corresponding cognitive levels (**See Appendices: I1, I2, I3, J1, J2 and J3**). Again, four content analysts worked independently when mapping the content standards and DBE workbook activities on NGP with the cognitive levels. Mapping of content on the range of knowledge correspondence was based on identifying the range of patterns from both content standards and DBE workbook activities on NGP (**See Appendices: K1, K2, K3, L1, L2 and L3**).

Over and above that, quantitative data collection was done on a common framework, meaning content analysts used one framework for mapping content, unlike in the qualitative data, where content analysts mapped content independently. Here data collection focused on mapping content standards and DBE workbook activities with the cognitive levels, and those were represented by a score of one, which represented a hit. A hit is used to show that content has been mapped to an assessment activity. However, where content and assessment activities were found to be matching more than one cognitive levels, the score was divided evenly into decimal fractions to sum up to one (Polikoff & Porter, 2014). Content matrices and assessment matrices were developed in order to compare the proportions in terms of cognitive levels (**See Appendices: M1, M2, M3, N1, N2 and N3**).

3.3.3. Data Analysis

The qualitative data was analysed following the three criteria of content focus developed by Webb (1997) to expose the alignment between SPMCS and DBE workbook activities on NGP in terms of content structure, namely: (1) categorical concurrence; (2) DoK consistency; and (3) range of knowledge correspondence. In analysing categorical concurrence, the highest consistency of the trends and patterns that emerged from data was considered. Comparison of content identified from content standards and the DBE workbook activities on NGP was done to indicate the level of agreement for each category. The units of comparison on this category were the sub-topics covered on content standards and DBE workbook activities on NGP. The scale of agreement used in the categorical concurrence included ‘full’, ‘acceptable’ and ‘insufficient’.

The ‘full’ level of agreement was applicable where one-to-one content was identified in both SPMCS and DBE workbook activities on NGP. The ‘acceptable’ level of agreement was applicable where nearly all the content was covered in both SPMCS and DBE workbook activities on NGP. The 'insufficient' level of agreement was applicable where important content had been excluded from the DBE workbook activities on NGP. The researcher adapted Webb's alignment model to suit the purpose of this study.

In analysing the DoK consistency, the cognitive level of the content on the content standards and DBE workbook activities was compared, with special emphasis on areas of commonality. The comparison between the cognitive level, identified from the content standards and the DBE workbook activities, was done to identify the level of agreement for each category. This was done subsequently to identify the overall level of agreement on the criteria. The units of comparison were the cognitive levels of the content standards and the DBE workbook activities on NGP. The scale of agreement were 'full', 'acceptable' and 'insufficient'. The level of agreement 'full' was applied where the cognitive level of the content standards was the same as the cognitive level of the assessment activities. Moreover, the level of agreement 'acceptable' was applied where the cognitive level of the content standards was nearly the same as the cognitive level of the assessment activities. The 'insufficient' level of agreement was applied where cognitive level of the content standards was not aligned to the cognitive level of most of the assessment activities.

Analysing the range of knowledge correspondence was based on commonality of the range of patterns between the content standards and the DBE workbook activities on NGP. The ranges of patterns identified from the content standards were identified and compared with the ranges of patterns identified on the DBE workbook activities. The units of comparison in this category were the range of patterns covered by the content standards and the DBE workbook activities on NGP. The scale of agreement for this category included 'full', 'acceptable' and 'insufficient'. The level of agreement, 'full' was applicable when the full range of patterns on content standards were covered by the assessment activities. Further, the level of agreement 'acceptable' was applied where nearly all the ranges of patterns for content standards was covered by the assessment activities. Again, ‘insufficient’ level of agreement was applicable when the major concepts on the content standards were excluded on the assessment activities.

In addition, quantitative data was analysed and presented statistically by means of Porter’s alignment model. Two matrices were developed, one for the content and another for the assessment. Proportions based on the cognitive levels from the content matrix were calculated by dividing proportions by the number of content standards. On the other hand, the proportions for the cognitive levels on the assessment matrix were calculated by dividing proportions by the number of assessment activities. Therefore, the alignment indices were calculated by comparing cell-by-cell proportions.

Porter’s (2002) alignment index was employed by adding the absolute differences between the proportions on the matrices (content and assessment) for each grade. The difference was then divided by 2, thereafter subtracting the quotient from 1 to get the alignment index. The total cognitive score points, total proportions, alignment indices and discrepancies were also calculated to give the status of alignment. The researcher also developed instruments to organise the proportions obtained on both content and assessment for the efficient and effective data analysis. Data visualisation in graphical and table format was represented to highlight the alignment in both representations. Besides, narrative analysis was also employed to make sure that disconnected data was cohered and interpreted.

3.3.4. Ethical Considerations

In sampling documents for analysis, documents were fully described to enable readers to understand, and future researchers to evaluate the content of the documents under exploration. Permission to conduct the study was solicited from the DBE for having sampled their working documents (**See Appendix: C**).

Sampling was well explained to clarify the population, sample and how the sample was chosen.

The researcher appointed four content analysts to collect data to ensure objectivity and honesty (Resnick, 2015). In trying to protect the data collected, only two professionals in the field of research were allowed to review data to ensure that published data was trustworthy and to improve the quality of the study (Kelly, Sadeghieh, & Adeli, 2014). All data collected was transcribed into a common instrument for analysis purposes and all data was kept safe until the report had been completed and reviewed. The researcher applied for ethical clearance from the Turfloop Research and Ethics Committee (TREC) before commencing with data collection to minimise risks and maximise results (Thomas, 2017) (**See Appendix: B**).

Since data was collected by content analysts, informed consent was exercised, where content analysts were first appointed and trained on the process of mapping the SPMCS and DBE workbook activities with the cognitive levels and the Webb's criteria of content focus. Content analysts were also informed about voluntary participation, so as to be able to take informed decisions and provide truthful information (Akaranga & Makau, 2016). Over and above that, content analysts were given appointment letters and consent forms before data collection process (**See Appendices: E and F**).

In this study, the researcher used fictitious names for content analysts such as A, B, C and D, and their details and contributions were not revealed (Akaranga & Makau, 2016). Furthermore, the risks and benefits were well explained to the content analysts in order to clear preconceived ideas. The researcher was careful when analysing data, and so used Excel to deal with calculations to avoid errors. The researcher critically examined all the records and data collected to avoid careless mistakes (Tichapondwa, 2013).

3.4. Quality criteria

The following elements for quality criteria were employed in this study: (1) credibility, (2) dependability, and (3) confirmability.

3.4.1. *Credibility*

Various techniques were employed to ensure credibility of this study, including triangulation, peer scrutiny and member checks. Triangulation in research refers to the use of more than one research approach to investigate a study (Heale & Forbes, 2013). Two types of triangulation were employed in this study: triangulation paradigm and theory triangulation. The triangulation paradigm was employed sequentially where two research approaches were employed to analyse the same research problem, first with the qualitative research approach then followed by the quantitative research approach. The aim was to produce comprehensive results.

Furthermore, theory triangulation was employed, where two alignment models were employed as the theoretical framework guiding this study. Again, theory triangulation was done sequentially where the alignment model of Webb (1997) was employed first to explore alignment in terms of the content structure. After that, the alignment model of Porter (2002) was employed to explore alignment in terms of the alignment indices. Thereafter, the results from different theories were collaborated for comprehensive results.

Peer scrutiny allows peers to have an advanced preview of the study before publication to prevent unreliable reporting (Vercellini, Buggio, Vigano, & Somigliana, 2016). Member checks represent a technique for exploring the credibility of the results by allowing respondents to check the results (Birt, Scott, Cavers, Campbell, & Walter, 2016). Peer scrutiny and member checks were employed in this study during the content mapping process and at the conclusion. This was done to allow professionals or experts in the research field to check the processes and the results with the purpose of providing guidance and feedback

(Zohrabi, 2013). The researcher also took it upon herself to understand the core issues of this study by observing the content analysts during the process of mapping content (Anney, 2014).

3.4.2. Dependability

The following techniques were employed in this study to ensure dependability: audit trail, code-recode and peer scrutiny. Audit trail is a system of recording all the steps taken in conducting the study (Korstjens & Moser, 2018). The audit trail was ensured by recording and keeping records of all the processes and activities undertaken to conduct this study as a point of reference for future studies (Anney, 2014). All records of raw data in this study were submitted to the Faculty of Humanities and electronic copies were kept in the computer as back-up (Major & Savin-Baden, 2012). The content analysts' content mapping was transcribed into an Excel spreadsheet for future reference, analysis and review.

Code-recode is when the researcher code data more than once, then compares their results at a later stage (Ary, Jacobs, Irvine, & Walker, 2018). Code-recode was demonstrated by allowing the content analysts first to map content independently before employing the common framework (Chilisa, 2012). Peer scrutiny, as described under credibility, was also employed to ensure that the results for this study are reliable. The researcher allowed peer scrutiny to take place during and after the conclusion of this study. The experts or professionals in the field of mathematics such as district and provincial co-ordinators, were consulted as peers to provide guidance and feedback.

3.4.3. Confirmability

This criteria played a pivotal role in avoiding personal biasness on this study (Bryman, 2016). The following strategies were used to ensure the confirmability of this study: reflexive journal, audit-trail and triangulation (De Chesnay, 2015). Reflexive journal is an instrument used for self-review on one's activities (Alexandrache, 2014). A study journal was kept to track all the processes, activities, reflections and data collected for this study appropriately. This was done in order to review the processes and the activities that took place during the study with the aim of improvement. On the other hand, audit trail and triangulation as described on credibility were also employed in this study to ensure confirmability. Two alignment models and two research approaches were employed to help produce comprehensive results, as a way of triangulating the research approaches and alignment models.

3.5. Conclusion

The research approach employed in this study was mixed methods research to produce comprehensive results. The exploratory sequential design was employed to enable future researchers since little literature was noted on the alignment between content standards and DBE workbook activities. The exploratory sequential design assisted in corroborating the qualitative data and the quantitative data. Data was obtained solely by analysing documents. The expertise of content analysts was utilised to map content and cognitive level of the SPMCS and DBE workbook activities on NGP. Eighteen qualitative data collection instruments were used to collect data following the Webb's (1997) criteria of content focus. Still, eight quantitative data collection instruments were used to collect data following Porter's (2002) alignment model. Data was analysed through identifying highest common trends and calculation of alignment indices to explore the status of alignment between SPMCS and DBE workbook activities on NGP. The data was interpreted and presented using tables, line graphs and bar plots. Lastly, narrative analysis was used for data coherence. The following chapter will focus on the interpretation of data.

4. CHAPTER FOUR
PRESENTATION AND INTERPRETATION OF FINDINGS

4.1. Introduction

This chapter presents the findings of this study where two alignment models were employed to guide this study, which are: Porter (2002) and Webb (1997). This chapter also presents the status of alignment in terms of the content structure for SPMCS and DBE workbook activities on NGP using Webb's (1997) alignment model. Again, this chapter outlines the status of alignment in terms of the alignment indices between the SPMCS and DBE workbook activities on NGP using Porter's (2002) alignment model. The qualitative data are presented in tables and interpreted in a coherent manner, while quantitative data are presented in tables, line graph, bar plot and interpreted using descriptive statistics.

4.2. Data Management and Analysis

Data were constructed by the subject advisors who served as content analysts through the use of document analysis. Documents that were analysed include the senior phase mathematics CAPS document and senior phase mathematics DBE workbooks containing NGP assessment activities. Two alignment models were employed to analyse the data and for the purpose of triangulation which were: Webb (1997) and Porter 2002). Webb (1997) was used to analyse qualitative data, while Porter (2002) was used to analyse the quantitative data. The use of Webb (1997) focused on exploring alignment in terms of the content structure, while Porter (2002) focused on exploring alignment in terms of alignment indices. The researcher believes that the findings of this study may contribute towards the development of qualitative assessments and learning materials in future.

The mapping of qualitative data was done individually by the content analysts and their results were compared with specific emphasis on areas of commonality and consistency. The reliability of content analysts' mapping of content on the qualitative data was ensured by employing Krippendorff alpha as the most reliable alpha. Krippendorff alpha is commonly used in content analysis to quantify the agreement and disagreement of raters (Krippendorff, 2011). The mapping of the quantitative data were done on a common framework where content analysts' views were compared. Statistical tools such as Excel spreadsheets were used to generate descriptive statistical data and to facilitate effective and efficient calculation of alignment indices and discrepancies. Quantitative data were interpreted and represented in the form of tables, line graphs and bar plot for readability.

This study sought to answer one main research question and two sub-research questions:

The main research question was as follows:-

- To what extent are the senior phase mathematics content standards aligned with the Department of Basic Education workbook activities on numeric and geometric patterns?

The sub-research questions were;

- What content structure do the senior phase mathematics and Department of Basic Education workbook activities on numeric and geometric patterns have?
- How do the senior phase mathematics content standards align with the Department of Basic Education workbook activities on the numeric and geometric patterns' content standards?

4.3. Alignment of Content Structure of SPMCS and DBE Workbook Activities on NGP

Research results were analysed in two stages. In the first stage, qualitative data were analysed to explore the degree of alignment in terms of the content structure of the SPMCS and DBE workbook activities on NGP. The content structure was analysed following the Webb's (1997) criteria of content focus. The results from the qualitative data are presented following the three criteria of content focus as outlined by Webb (1997), namely: (1) categorical concurrence, (2) depth of knowledge consistency, and (3) range of knowledge correspondence. The researcher opted for the three criteria of content focus, leaving out the other three criteria which are: balance of representation; structure of knowledge comparability; and dispositional consonance. These criteria were not considered simply because the balance of representation clarifies the amount of emphasis and weighting of content, and the weighting of content in CAPS has been done according to content areas, while topics are weighted in terms of time allocation.

The criterion on balance of representation was therefore not considered, since this study focused on a topic rather than the content area. The structure of knowledge comparability was not considered because it deals with how learners connect learning with different ideas, and is not the focus of this study. The other criterion that was not considered is the dispositional consonance since it deals with learners' attitudes and beliefs which is not the focus for this study. The findings in terms of Webb's (1997) criteria of content focus are presented below:

4.3.1. Categorical Concurrence

Categorical concurrence was explored in this study to verify alignment of content between SPMCS and DBE workbook activities on NGP. Content refers to the concepts and skills to be covered in the senior phase mathematics classroom. Here the focus was on comparing and verifying the consistency of content in both SPMCS and DBE workbook activities on NGP. The units of comparison were the sub-topics covered on content standards and DBE workbook activities on NGP.

The comparison was based on the content covered on both SPMCS and DBE workbook activities on NGP. In comparing the two units, the scale of agreement was also employed to categorise the depth of consistency of the content. The scale of agreement included 'full', 'acceptable' and 'insufficient'. The 'full' level of agreement was applicable where one-to-one content was identified in both SPMCS and DBE workbook activities on NGP. The 'acceptable' level of agreement was applicable where nearly all the content was covered in both the SPMCS and DBE workbook activities on NGP. The 'insufficient' level of agreement was applicable where important content had been excluded from the DBE workbook activities on NGP.

The three levels of agreement on categorical concurrence recommended by Webb (1997) fit well with the findings. However, they did not include a level of agreement where the content on the assessment is beyond the scope of the content standards. The findings from the primary data of this study included the content of DBE workbook activities that is beyond the scope of the content standards. The researcher then extended the scale of agreement to include 'not applicable' to cater for the content of assessment that is beyond the scope of the content standards. Webb's alignment model was adapted to suit the purpose of this study. The results for Grade 7 categorical concurrence are presented below.

- GRADE 7 CATEGORICAL CONCURRENCE

Categorical concurrence for Grade 7 was explored to determine the content covered by the content standards and the DBE workbook activities on NGP. Table 4.1 below shows the content identified on the mathematics Grade 7 content standards on NGP.

Table 4. 1: Grade 7 content identified on NGP's content standards

Content Standards on NGP		Content identified
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:		Investigation and extension of:- • Numeric patterns.
	• represented in physical or diagram form.	• Geometric patterns/patterns in physical or diagrammatic form.
	• not limited to sequences involving a constant difference or ratio.	• Patterns with constant difference.
		• Patterns with constant ratio.
		• Patterns with neither constant difference nor ratio.
	• of learner's own creation.	• Patterns from learners' own creation.
	• Represented in tables.	• Representation of patterns in tables.
2. Describe and justify the general rules for observed relationships between numbers in own words.		• Description of general rules of patterns in own words

Table 4.1 shows the content identified on the mathematics Grade 7 content standards on NGP. Content standards have been outlined and the content identified on the content standards have been outlined. The content identified on the content standards for Grade 7 was compared with the content identified on the DBE workbook activities on NGP. This was done to verify the consistency of content between the two components. The content identified on DBE workbook activities by the content analysts was categorised in terms of similarity of content. Where assessment activities assessed same content, assessment activities were grouped together to avoid unnecessary repetition. Table 4.2 below shows the content identified on the mathematics Grade 7 DBE workbook activities on NGP.

Table 4. 2: Grade 7 content identified on NGP's DBE workbook activities

Worksheet	Activity	Content identified
WS 65	1	• Description of patterns represented by number lines.
WS 65	2	• Description of the rule of numeric patterns with constant difference in own words.
WS 65	S	• Creation of own pattern.
WS 66	1	• Description of the rule of numeric patterns with constant ratio in own words.
WS 66	PS	• Creation of own patterns.
WS 67	1	• Description of the rule of numeric patterns with neither a constant difference nor ratio and draw number line.
WS 67	PS	• Creation of own pattern.
WS 68	1	• Description of the rule and draw a number line.
WS 68	2	• Calculation of the term on tables.
WS 68	PS	• Solving of patterns in context.
WS 69	1	• Description of the rule in own words & calculation of the term.
WS 69	PS	• Solving of patterns in context.
WS 70	1	• Creation of geometric patterns & completion of the table.
WS 70	2	• Explanation of terms on patterns and giving examples.
WS 70	PS	• Representation of a geometric pattern.
WS 71a	1	• Description of the sequence in words, representation of patterns on number line, completion of a table, Writing of patterns in algebraic language and determination of their values.
WS 71b	PS	• Calculation of the term given the rule in algebraic language.
WS 114	1	• Description of pattern on number lines.
WS114	2&3	• Description of the patterns in words.
WS 114	PS	• Solving of patterns in context.
WS 115	1	• Description of the pattern and making of a diagram to show the value of the term.
WS 115	2&3	• Calculation of the value of the term in tables.
WS 115	PS	• Solving of patterns in context.
WS 116	1	• Calculation of the term & description of the rule in words.
WS 116	PS	• Solving of patterns in context.
WS 117a	1	• Writing pattern on a number line, writing of pattern on the table, description of the rule in algebraic language and getting the values of the terms.
WS 117b	PS	• Writing the rule for the pattern.

Table 4.2 above shows the content identified on the DBE workbook activities on NGP for mathematics Grade 7. Twenty seven assessment activities have been outlined and the content identified on each assessment activity has been highlighted. Table 4.3 below shows the comparison of content identified from both Grade 7 content standards and DBE workbook activities on NGP.

Table 4. 3: Comparison of Grade 7 content identified on NGP's content standards and DBE workbook activities

Content identified on content standards	**Content identified on DBE workbook activities**	**Scale of agreement (Full/acceptable/insufficient/ not applicable)**
1. Investigation and extension of:- • Numeric patterns.	• Description of numeric patterns.	Acceptable
• Geometric patterns/patterns in physical or diagrammatic form.	• Creation of geometric patterns. • Representation of a geometric pattern.	Full
• Patterns with constant difference.	• Description of patterns with constant difference.	Acceptable
• Patterns with constant ratio.	• Description of the patterns with constant ratio.	Acceptable
• Patterns with neither constant difference nor ratio.	• Description of the rule of patterns with neither a constant difference nor ratio.	Acceptable
• Patterns from learners own creation.	• Creation of own pattern.	Full
• Patterns represented in tables.	• Completion of the table. • Writing of a pattern on the table.	Full
2. Description of general rule of patterns in own words.	• Description of the rule in own words.	Full
	• Description of patterns represented by number lines. • Description of the rule and the drawing of number line. • Writing of pattern on a number line.	Not applicable
	• Calculation of the term on tables.	Not applicable
	• Solving of patterns in context.	Not applicable
	• Writing of patterns in algebraic language and determination of their values. • Calculation of the term given the rule in algebraic language.	Not applicable
	• Description of the pattern and making a diagram to show the value of the term.	Not applicable
Overall level of agreement		**Acceptable**

Table 4.3 above illustrates the comparison between the content identified on the content standards for mathematics Grade 7 and DBE workbook activities on NGP. According to the analysis, content identified on the content standards were also identified on the assessment activities, ranging from 'acceptable' level of agreement to 'full' level of agreement. Again, 'not applicable' level of agreement

was also identified, where the content beyond the scope of the content standards was identified on the DBE workbook activities. To illustrate the analysis, the content standard that expected learners to investigate and extend numeric patterns was partly covered by the DBE workbook activities, hence allocated the 'acceptable' level of agreement instead of 'full'. Numeric patterns were found in the DBE workbooks, but not requiring learners to investigate and extend the patterns. In most of the number pattern activities, learners were required to describe the rule, instead of extending the pattern. Examples of such activities are extracted from Grade 7 mathematics DBE workbook and are given below:

- Describe the rule for each pattern.
  - 6, 14, 22, 30
- Describe the pattern.
  - 2,8,32,128,512
- Describe the pattern and draw a number line to show each.
  - 8,10,14,20,28
- Describe the rule in your own words. Calculate the 20th term using a number sequence.
  - 2,5,10,17

Webb (1997) emphasises that learners should be assessed on what they are expected to know or what is expected as important knowledge in the content standards. This must be the case, since alignment is the coherence that must exist between content standards and assessment in order to enhance the effectiveness of the education system (Watermeyer, 2012). A discrepancy was identified on the content that expected learners to describe the general rule of patterns. The description of general rules in algebraic language was found to be beyond the scope of the content standard. However, the teaching guidelines made mention of the description of the general rule in algebraic language. This creates gaps between the content standards and the teaching guidelines. Hence, it is important for content standards to have same content as that of the teaching guidelines without contradiction. The assessment activity that expected learners to investigate and extend geometric patterns had fully covered the corresponding content standard. The following example is one of such an activity and has been extracted from Grade 7 mathematics DBE workbook.

- Create the first three terms of the following patterns with matchsticks and then draw the patterns in your book. Complete the tables.
    - Triangular pattern.
    - Square pattern.
    - Rectangular pattern.

These activities confirm that the assessment activity that expected learners to investigate and extend geometric patterns had fully addressed the content standard. The assessment activity that expected learners to investigate and extend patterns with constant difference, constant ratio, and neither constant difference nor constant ratio, had acceptably covered the corresponding content standard. This indicates that the DBE workbook activities partly addressed this particular content standard. Patterns with constant difference, constant ratio and neither constant difference nor constant ratio were found in the DBE workbooks, but did not require learners to investigate and extend patterns. The activities in the DBE workbooks required learners to describe the patterns and not asked them to extend the patterns, as per the content standard. The following examples confirm such a finding which has been extracted from Grade 7 DBE workbook activities on NGP.

Patterns with constant difference.

- Describe the rule for each pattern.
    - 13,10,7,4,1
    - 8,13,18,23,28

Patterns with constant ratio.

- Describe the pattern.
    - 4,12,36,108,324
    - 6,12,24,48,96

Patterns with neither constant difference nor ratio.

- Describe the pattern and draw a number line to show each.
    - 8,10,14,20,28
    - 3,6,10,15,21

It is imperative that assessment should assess what it is expected to assess, unlike assessing content beyond the scope of the content standards. This creates gaps, since one may not be in a position to measure whether the expected objectives have been achieved or not. Developers of assessments should be aware that assessment should be meant to measure what is expected to be learnt by the learners (Porter, 2002). Again, the assessment activity that expected learners to investigate and extend patterns from learners' own creation had covered all the content of the corresponding content standard. The example of such findings has been extracted from the mathematics Grade 7 DBE workbook and is indicated below:

Create your own sequence without a constant ratio.

Another content standard that was fully covered by the DBE workbook activities is the one that expected learners to describe the general rule of patterns in words. The following examples have been extracted from the mathematics Grade 7 DBE workbook which confirms full level of agreement with the content standard.

- Describe the rule for each pattern.
    - 13,10,7,4,1

- Describe the rule in your own words.
    - Number sequence: 2,5,10,17

This shows that some of the assessment activities from DBE workbook are fully aligned with the content standards. One more assessment activity that covered the content of the corresponding content standard on NGP for mathematics Grade 7, is an assessment activity that expected learners to investigate and extend patterns represented in tables. The following example confirms full level of agreement, and has been extracted from the mathematics Grade 7 DBE workbook.

- What will the term be?.

Position in the sequence	1	2	3	4		100
Value of term	12	24	36	48		

In contrast, the analysis revealed that the DBE workbook also assessed content beyond the scope of the content standards for mathematics Grade 7. The researcher used ‘not applicable’ to cater for that category, since a gap was identified from Webb’s alignment model. The following examples confirm such findings and have been extracted from Grade 7 mathematics DBE workbooks.

Patterns represented by number lines.

- Describe the pattern and draw a number line to show each.
    - 8, 10, 14, 20, 28

- Describe each pattern.

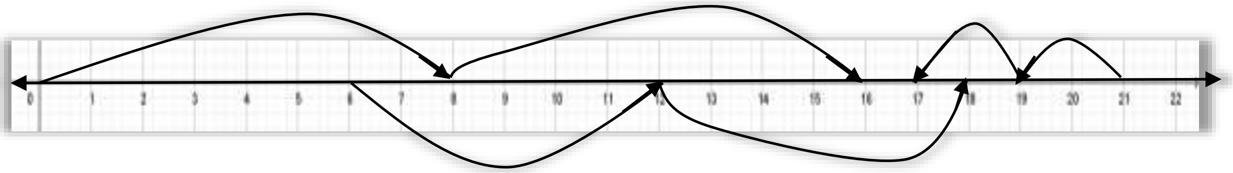


Figure 4. 1: Number line (DBE, 2017, p.3)

Calculation of a term value.

- Calculate the 20th term.
  - Number sequence: 8,14,20,26
  - Number sequence: -4,-5,-6,-7

Solve patterns in context.

- Brenda collects shells. Every day she picks up double the amount of the previous day. On day 1 she picks up 8 shells. On day 2 she collects 16. How many shells will she pick up on day 3 if the pattern continues? Write down the rule.

Patterns represented in algebraic language.

- What is the 30th term if the nth position is 8(n)-7?.
- Describe the sequence in difference ways using the template provided.
  - Where n is the position of the term.

-1, 2, 5, 8

Patterns represented on a drawing.

- Describe the pattern and make a drawing to show the value of each term.
  - Example: 15,22,16,21,17

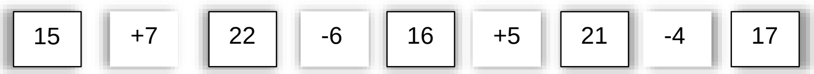


Figure 4. 2: Drawing (DBE, 2017, p.110)

The above examples reveal that a discrepancy exists between mathematics Grade 7 DBE workbook activities on NGP and the content standards. However, Webb's alignment model does not cover the level of agreement when the content assessed is beyond the scope of the content standards. This justifies the gap identified on Webb's alignment model. The researcher adapted Webb's alignment model to suit the research questions, and hence made extension on the scale of agreement. The researcher extended the level of agreement where content on assessment was found to be beyond the scope of the content standards as 'not applicable'. This indicates that the content assessed is not applicable to the content standards. These kinds of discrepancies need to be addressed in future, to cater for a level of agreement when the content assessed is beyond the scope of the content standards.

The implication of assessing content beyond the scope of the content standards is that, learners could be subjected to content that is pitched at low or high level, which could create challenges to learners' cognition in mastering the concepts. It is therefore important to pitch activities to the level of the content standards to avoid causing damage to learners' cognition. Webb (1997) highlights that content should be consistent in both content standards and assessment. This means, the same content covered by the content standards should be the same as the content covered on the assessment activities.

Therefore, the level of agreement for the categorical concurrence between the content standards and DBE workbook activities on NGP for Grade 7 is acceptable. The DBE workbook activities on NGP covered sufficient number of content prescribed on the content standards. Again, the content assessed on DBE workbooks which was beyond the scope of the content standards created gaps. This may have a negative impact on learners' cognition on NGP and time allocation for the topic. The challenge could be on teachers adequately teaching the content that is beyond the scope of the content standards. The following topic discussed is the Grade 8 categorical concurrence.

- GRADE 8 CATEGORICAL CONCURRENCE

The exploration of categorical concurrence was also extended to Grade 8, to verify whether content covered by the content standards is consistent with the content covered by the DBE workbook activities on NGP. The content identified on the content standards for mathematics Grade 8 is indicated in Table 4.4 below.

Table 4. 4: Grade 8 content identified on NGP's content standards

Content standards on NGP		Content identified
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:		Investigation and extension of:- • Numeric patterns.
	• represented in physical or diagram form.	• Geometric patterns/patterns in physical or diagrammatic form.
	• not limited to sequences involving a constant difference or ratio.	• Patterns with constant difference.
		• Patterns with constant ratio.
		• Patterns with neither constant difference nor ratio.
	• of learner's own creation.	• Patterns from learners' own creation.
	• represented in tables.	• Patterns represented in tables.
	• represented algebraically.	• Patterns represented algebraically.
2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.		Description of general rule of patterns in own words.

Table 4.4 shows the content identified from the content standards on NGP for mathematics Grade 8. Content standards have been outlined and the content identified from content standards are outlined. The content on the DBE workbook activities on NGP was also identified in order to make a comparison with the content identified on the content standards. The purpose of this was to verify consistency of content between the two components. Table 4.5 below shows the content identified on the DBE workbook activities on NGP for mathematics Grade 8.

Table 4. 5: Grade 8 content identified on NGP's DBE workbook activities

Worksheet	Activity	Content identified
WS 27a	1,2&4	Identification of numeric patterns with constant difference and constant ratio.
WS 27a	3	Checking if patterns have constant difference or constant ratio.
WS 27a	5	Completion of the table, stating the rule & determination of the term value.
WS 27a	PS a	Creation of own pattern.
WS 27a	PS b	Drawing of diagrams to illustrate arithmetic patterns.
WS 27b	1	Extension of geometric pattern.
WS 27b	2	Calculation of number of match sticks used.
WS 27b	3	Recording of results on table.
WS 27b	4	Completion of the table.
WS 27b	5	Drawing and completion of the table using algebraic language.
WS 27b	PS a	Drawing of geometric patterns, identification of the rule & completion of the table.
WS 27b	PS b	Completion of the table.

Table 4.5 above shows the content identified on the DBE workbook activities on NGP for the mathematics Grade 8. Twelve assessment activities were outlined and the content identified from each assessment activity was also outlined. Furthermore, the comparison between the content identified on the content standards and the DBE workbook activities on NGP was done to check if the content covered by both components are consistent. Table 4.6 below illustrates the comparison between the content identified from the content standards for Grade 8 and the content identified from the DBE workbook activities on NGP.

Table 4. 6: Comparison of Grade 8 content identified on NGP's content standards and DBE workbook activities

Content identified on content standards	**Content identified on DBE workbook activities**	**Scale of agreement (Full/acceptable/insufficient/ not applicable)**
1. Investigation and extension of :- • Numeric patterns.	• Identification of numeric patterns with constant difference, constant ratio and reason for not having constant difference.	Acceptable
• Geometric patterns or patterns in physical or diagrammatic form.	• Extension of geometric pattern. • Drawing of diagrams to illustrate arithmetic patterns. • Drawing of geometric pattern.	Full
• Patterns with constant difference.	• Identification of constant difference on numeric patterns.	Acceptable
• Patterns with constant ratio.	• Identification of constant ratio on numeric patterns.	Acceptable
• Patterns with neither constant difference nor ratio.	• Checking if patterns have constant difference or constant ratio.	Acceptable
• Patterns from learners own creation.	• Creation of own patterns.	Full
• Patterns represented in tables.	• Completion of the table. • Recording of results on the table. • Drawing and completion of the table using algebraic language.	Full
• Patterns represented algebraically.	• Drawing and completion of the table using algebraic language.	Full
2. Description of general rule of patterns in own words or in algebraic language.	• Stating of the rule. • Identification of the rule.	Full
	• Determination of the term value.	Not applicable
	• Calculation of number of match sticks used.	Not applicable
Overall level of agreement		**Acceptable**

Table 4.6 above shows the comparison between content identified on the content standards and DBE workbook activities on NGP as well as the level of agreement for both components. From the comparison, almost all the content prescribed on the content standards for the Grade 8 mathematics have been covered by the DBE workbook activities on NGP. However, content beyond the scope of the content standards were also identified from the DBE workbook activities. To illustrate the analysis, the assessment activities that required learners to investigate and extend numeric patterns had acceptably covered the corresponding content standard. An example of this finding has been extracted from mathematics Grade 8 DBE workbook and is indicated below:

- What is the constant difference between the consecutive terms?.
  - 3,5,7,9
- What is the constant ratio between the consecutive terms?.
  - 3,9,27,81

The assessment activity that needed learners to investigate and extend geometric patterns fully covered the corresponding content standard. The following example shows that the assessment activities had fully covered the corresponding content standard.

- Draw diagrams to illustrate the arithmetic patterns in question 2a and d and the geometric patterns in 5a and d.
- Draw more matchsticks to make the next pattern in a sequence of hexagon. What will the next pattern be? The rule: add one matchstick to each side.

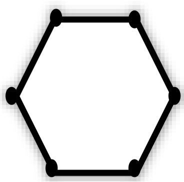


Figure 4. 3: Hexagon pattern (DBE, 2017, p.55)

The assessment activity that expected learners to investigate and extend patterns with constant difference, constant ratio and neither the constant difference nor the constant ratio had acceptably covered the corresponding content standard. The activities on DBE workbooks only focused on identifying the constant difference and constant ratio, and not asked them to extend the patterns. Furthermore, the content that expected learners to investigate and extend the pattern from learners' own creation had fully covered the corresponding content standard. An example that supports this finding has been extracted from the mathematics Grade 8 DBE workbook and has been indicated below:

- If the constant ratio is -8 what could a sequence of numbers be?.

Similarly, the assessment activity that expected learners to investigate and extend patterns represented in tables had fully covered the corresponding content standard. The example of this finding has been extracted from the mathematics Grade 8 DBE workbook and has been indicated below:

- Complete the table then state the rule.

Position	5	15	25	35	n
Value of the term	12	22			

It is recommended that the content standards be aligned to instruction, assessment, learning materials and professional development (Porter, 2002). It is believed that this kind of alignment is capable of enhancing learner achievement (Gibbs, 2012). Another content standard that was fully covered by the DBE workbook activities, is the content standard that expected learners to investigate and extend patterns represented algebraically. The following is an example of this finding, extracted from the mathematics Grade 8 DBE workbooks.

- Draw and complete your own tables using the following information.
    - $4(n) + 1$

Term						n
Value of the term						

This confirms that the content standard that expected learners to investigate and extend patterns represented algebraically was fully covered by the DBE workbook activities. Another content standard that was fully covered by the DBE workbook activities on NGP for mathematics Grade 8, is the content standard that expect learners to describe the general rule of patterns in own words or in algebraic language. The following example confirms such findings and has been extracted from mathematics Grade 8 DBE workbook.

- Complete the table and state the rule.
  - 13, 25, 37, 49

Term	1	2	3	4	22	n
Value of the term						

It is not specified on the DBE workbook activities on how the description of general rule should be. The corresponding content standard specifies that the description should be in own words or in algebraic language. It is important that the description of general rules of patterns be specified, since two options are indicated on the content standards. This is raised since a guideline is given on how general rule of patterns should be described on the content standards. The general rule of patterns should be described in own words or in algebraic language. It is important to phrase assessment activities in a manner that will help to evaluate whether content standards have been achieved or not. Assessment activities on mathematics Grade 8 DBE workbooks did not specify how the general rule should be described. The following highlights such discrepancy and has been extracted from the Grade 8 DBE workbook.

- Draw the first three terms of a triangular number pattern (as you did for the hexagon using matches in question 1, identify the rule.

These create gaps, since guidelines on how to describe general rules of patterns have been outlined in CAPS. Again, the description of general rules in Grade 8 has given an option, where learners can describe in own words or in algebraic language. It is suggested that describing the general rule of patterns in own words and in algebraic language should not be put as optional. This is suggested since learners in Grade 7 are expected to describe the general rule of patterns in own words, and the content progression in Grade 8 expects learners to generalise the rules of patterns in algebraic language. It is recommended that the description of general rules of patterns be in own words and in algebraic language, rather than be put as optional. It is therefore imperative to use the verbs outlined on the content standards as recommended by Biggs (2014).

Another discrepancy was identified where some of the content covered by the DBE workbook activities were beyond the scope of the content standards. An example of such findings is given below and has been extracted from the mathematics Grade 8 DBE workbook activities on NGP.

Calculating the term value.

- Determine the term value as asked.
- What will the value of the 20th term be?.

Position	2	4	6	8	n
Value of the term	4	8		16	

The above assessment requires learners to calculate the term value. Calculation of the term value was beyond the scope of the content standard. Only investigation, extension, justification and description of patterns are mentioned on the content standards. The implication of the content beyond the scope of the content standards is that, teachers might adequately teach the concepts that are beyond the scope of the content standards. And as a result, measuring learners' achievement in terms of the content standards might be a challenge, since the content is beyond the scope of the content standards. Again, Webb's alignment model does not cover the level of agreement when the content assessed is beyond the scope of the content standards. Modification on the scale of agreement was made to suit this study. It is suggested that such extension on the scale of agreement could be made in future to cater for situation where beyond the scope content is assessed. The researcher used 'not applicable' to cater for content assessed not prescribed on the content standards.

The level of agreement on the mathematics Grade 8 categorical concurrence was acceptable. According to Webb (1997), categorical concurrence is acceptable when assessment covers sufficient topics on the content standards.

❖ GRADE 9 CATEGORICAL CONCURRENCE

The exploration of categorical concurrence was also extended to Grade 9, where content covered by the content standards and DBE workbook activities was identified and compared. This was done to verify the consistency of content between the two components. The content identified on content standards for Grade 9 has been indicated in Table 4.7 below.

Table 4. 7: Grade 9 content identified on NGP's content standards

<table>
<tr><th colspan="2">Content standards on NGP</th><th>Content identified</th></tr>
<tr><td rowspan="8">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td><td></td><td>Investigation and extension of:-
• Numeric patterns.</td></tr>
<tr><td>• represented in physical or diagram form.</td><td>• Geometric patterns/patterns in physical or diagrammatic form.</td></tr>
<tr><td rowspan="3">• not limited to sequences involving a constant difference or ratio.</td><td>• Patterns with constant difference.</td></tr>
<tr><td>• Patterns with constant ratio.</td></tr>
<tr><td>• Patterns with neither constant difference nor ratio.</td></tr>
<tr><td>• of learner's own creation.</td><td>• Patterns from learners own creation.</td></tr>
<tr><td>• represented in tables.</td><td>• Patterns represented in tables.</td></tr>
<tr><td>• Represented algebraically.</td><td>• Patterns represented algebraically.</td></tr>
<tr><td colspan="2">2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.</td><td>Description of general rule of patterns in own words.</td></tr>
</table>

Table 4.7 above shows the content identified from the mathematics Grade 9 content standards on NGP. Content standards were outlined, and the content identified from content standards were outlined. The content identified from the content standards was compared with the content identified from the DBE workbook activities on NGP. Table 4.8 below shows the content identified on the mathematics Grade 9 DBE workbook activities on NGP.

Table 4. 8: Grade 9 content identified on NGP's DBE workbook activities

Worksheet	Activity	Content identified
WS 27	1;2&3	• Description of the rule & extension of the number patterns with constant difference, constant ratio and neither the constant difference nor ratio.
WS 27	4	• Completion of the table.
WS 27	5	• Determination of the terms on the table.
WS 27	PS	• Creation of own pattern.
WS 28	1	• Creation and completion of the geometric patterns.
WS 28	2&3	• Completion of the table using the rule.
WS 28	PS	• Making of own rule and completion of the table.

Table 4.8 above shows the content identified on mathematics Grade 9 DBE workbook activities on NGP. Seven assessment activities were outlined and the content identified were also outlined. The content identified on the DBE workbook activities was compared with the content identified on the content standards. Table 4.9 below shows the comparison between the content identified from the content standards and DBE workbook activities on NGP.

Table 4. 9: Comparison of Grade 9 content identified on NGP's content standards and DBE workbook activities

Content identified on content standards	Content identified on DBE workbook activities	Scale of agreement (Full/acceptable/insufficient/ not applicable)
Investigation and extension of:- • Numeric patterns.	• Extension of the pattern.	Full
• Geometric patterns/patterns in physical or diagrammatic form.	• Creation and completion of the geometric patterns.	Full
• Patterns with constant difference.	• Extension of the pattern.	Full
• Patterns with constant ratio.	• Extension of the pattern.	Full
• Patterns with neither constant difference nor ratio.	• Extension of the pattern.	Full
• Patterns from learners own creation.	• Creation of own pattern.	Full
• Patterns represented in tables.	• Completion of the table. • Determination of the terms on the table.	Full
• Patterns represented algebraically.	• Completion of the table using the rule. • Making of own rule and completion of the table.	Full
• Description of general rule of patterns in own words or in algebraic language.	• Description of the rule.	Full
Overall level of agreement		**Full**

Table 4.9 shows a comparison between the content identified on content standards and DBE workbook activities on NGP for the mathematics Grade 9. All the content identified on content standards were covered in full by the DBE workbook activities on NGP. Content beyond the scope of the Grade 9 mathematics content standards was not assessed on DBE workbook activities as in Grade 7 and Grade 8. This confirms that the DBE workbook activities on NGP for Grade 9 were fully aligned with the content standards in terms of the content coverage. The following example is extracted from the mathematics Grade 9 DBE workbook. It addresses the content standard on investigation and extension of numeric patterns, not limited to sequences involving constant difference or constant ratio.

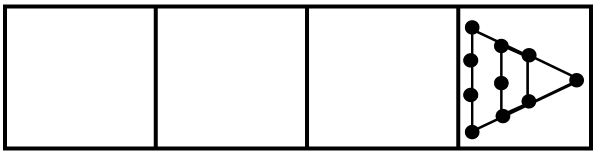
- Describe the pattern by giving the rule and then extend it with three more terms.
  - 2; 4; 6; 8; 10
- Describe the pattern by giving the rule and then extend it by three terms.
  - 2; 4; 8; 16; 32; 64
- Describe the pattern by giving the rule and then extend it by three terms.
  - 2; 4; 12; 48; 240

The assessment activities required learners to investigate and extend numeric patterns not limited to constant difference or constant ratio. In analysing the patterns, the first pattern has a constant difference of 2, the second pattern has a constant ratio of 2, and the third pattern has neither a constant difference nor a constant ratio. However, the second degree of the constant ratio can lead to a constant difference of 1. This shows that the constant ratio of the pattern is growing by 1. This confirms that not only patterns with constant difference or constant ratio were covered by the DBE workbook activities, but also patterns with neither a constant difference nor constant ratio were covered, as outlined on the content standards. Hence, these assessment activities are fully aligned with the content standard.

Correspondingly, the content standard that expected learners to investigate and extend geometric patterns was well covered in the mathematics

Grade 9 DBE workbook activities on NGP. The following example confirms that the corresponding content standard was fully covered and has been extracted from mathematics Grade 9 DBE workbook

- Create and complete the following geometric patterns.
    - Triangle.



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It is recommended that content standards be aligned to assessment and learning materials (Porter, 2002). Likewise, the content standard that expected learners to investigate and extend patterns of learners' own creation, patterns represented in tables as well as patterns represented algebraically, was fully covered by the DBE workbook activities on NGP for mathematics Grade 9. The following examples confirm full level of agreement and have been extracted from mathematics Grade 9 DBE workbooks.

Patterns of learners own creation.

- Create your own sequence as follows:
    - Constant difference between the consecutive terms.
    - Constant ratio between the consecutive terms.
    - Neither a constant difference nor a constant ratio.

Patterns represented in tables.

- Complete the table.

Position in sequence	2	4	6	8	10	n
Term	-10	-8	-6	-4		

Patterns represented algebraically.

- Use the rule to complete each table.

$y = 3x - 1$

x	-2	-1	0	1	2	10	50
y							

The assessment activity that expected learners to describe the general rule of patterns in own words and in algebraic language was incomplete in the DBE workbook, since it was not indicated whether the general rule should be in own words or in algebraic language. This is raised since the corresponding content standard indicates that the general rule of patterns can be described in own words or in algebraic language. The DBE workbook activities only asked the learners to describe the rule, and not provide specific guidelines on how the description should be. This criterion was fully covered according to the analysis, since the CAPS indicated it as optional: in own words or in algebraic language. It would be good for learners to describe the general rule of patterns in own words and in algebraic language, rather than in only one of the two.

This is raised since in Grade 7 learners are expected to describe the general rule in own words according to the content standards. So the progression in terms of content to Grade 8 and Grade 9 should be clear. This suggests that Grade 8 and Grade 9 assessment activities should require learners to describe the general rule of patterns in own words and in algebraic language, rather than being optional. Again, assessment activities should be asked in full without relying on examples for guidelines, since the questions are considered incomplete without the examples. An example of assessment activity that was incomplete, but provided an example to give a guideline on how it should be answered, is indicated below as extracted from Grade 9 DBE workbook:

- Describe the pattern by giving the rule and then extend it with three more terms.
    - -1, 5, 11, 17

    Example: 12; 14; 16 (Add 2 to the previous term).

This can be linked to describing the general rule in own words since the example provided is described in own words. In future such activities should be made clear by providing guidelines on what is expected. The framing of questions should be in line with the verbs used on the content standards to be well aligned as recommended by Biggs (2014). The level of agreement on this category is fully covered, since all the content from the content standards were covered by the DBE workbook activities on NGP.

4.3.2. Depth of Knowledge Consistency

This category was explored to verify whether the assessment activities on the DBE workbook activities on NGP measured the cognitive levels of the corresponding SPMCS. The cognitive level categorises the cognition level and the depth of understanding (Zhuge, 2016). The units of comparison included the cognitive levels of the content standards and the cognitive levels of the DBE workbook activities on NGP. The scale of agreement included 'full', 'acceptable' and 'insufficient'. The 'full' level of agreement was applied where the cognitive level of the content standards was the same as the cognitive level of the assessment activities. The 'acceptable' level of agreement was applicable where the cognitive level of the content standards were nearly the same as the cognitive level of the assessment activities. The 'insufficient' level of agreement was applied where the cognitive level of the content standards was not aligned to the cognitive level of most of the assessment activities.

❖ GRADE 7 DEPTH OF KNOWLEDGE CONSISTENCY

The depth of knowledge consistency was explored in Grade 7 to check whether the content standards and the DBE workbook activities on NGP measured the same cognitive levels. Table 4.10 below shows the cognitive levels of the content standards identified for Grade 7 on NGP.

Table 4. 10: Grade 7 cognitive levels identified on NGP's content standards

<table>
<tr><th colspan="2">Content standards on NGP</th><th>Cognitive levels identified</th></tr>
<tr><td rowspan="4">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td><td>• represented in physical or diagram form.</td><td>• Knowledge</td></tr>
<tr><td>• not limited to sequences involving a constant difference or ratio.</td><td>• Knowledge
• Routine procedures</td></tr>
<tr><td>• of learner's own creation.</td><td>• Knowledge</td></tr>
<tr><td>• represented in tables.</td><td>• Knowledge
• Routine procedures</td></tr>
<tr><td colspan="2">2. Describe and justify the general rules for observed relationships between numbers in own words or algebraic language.</td><td>• Knowledge
• Routine procedures</td></tr>
</table>

Table 4.10 above shows the cognitive levels identified for the content standards on NGP for Grade 7. These cognitive levels were compared with the cognitive levels of the DBE workbook activities on NGP. Table 4.11 below shows the cognitive levels of the DBE workbook activities for Grade 7 on NGP.

Table 4. 11: Grade 7 cognitive levels identified on NGP's DBE workbook activities

Worksheet	Activity	Cognitive levels identified
WS 65	1	Knowledge
WS 65	2	Routine procedures
WS 65	S	Knowledge
WS 66	1	Routine procedures
WS 66	PS	Knowledge
WS 67	1	Routine procedures
WS 67	PS	Knowledge
WS 68	1	Knowledge
WS 68	2	Routine procedures
WS 68	PS	Routine procedures
WS 69	1	Routine procedures
WS 69	PS	Routine procedures
WS 70	1	Knowledge
WS 70	2	Knowledge
WS 70	PS	Knowledge
WS 71a	1	Knowledge; routine procedures
WS 71b	PS	Routine procedures
WS 114	1	Knowledge
WS114	2&3	Routine procedures
WS 114	PS	Routine procedures
WS 115	1	Knowledge; routine procedures
WS 115	2&3	Routine procedures
WS 115	PS	Routine procedures
WS 116	1	Routine procedures
WS 116	PS	Routine procedures
WS 117a	1	Knowledge; routine procedures
WS 117b	PS	Routine procedures

Table 4.11 shows the cognitive levels identified from the DBE workbook activities on NGP for Grade 7. The cognitive levels of the content standards were compared with the cognitive levels of the DBE workbook activities to see if their cognitive levels were consistent. Table 4.12 below shows the comparison between the cognitive levels identified on the content standards and the cognitive levels identified from the Grade 7 DBE workbook activities on NGP.

Table 4. 12: Comparison of cognitive levels identified on NGP's content standards and DBE workbook activities for Grade 7

Content standards on NGP	**Cognitive levels identified on content standards**	**Cognitive levels identified on DBE workbook activities**	**Scale of agreement (Full/acceptable/ insufficient)**
1. Investigate and extend:- • Numeric patterns.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Geometric patterns/patterns in physical or diagrammatic form.	• Knowledge	• Knowledge	Full
• Patterns with constant difference.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns with constant ratio.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns with neither constant difference nor ratio.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns from learners own creation.	• Knowledge	• Knowledge	Full
• Patterns represented in tables.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
2. Describe general rule of patterns in own words.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
	Overall level of agreement		**Full**

Table 4.12 above shows the cognitive levels of the content standards and the DBE workbook activities on NGP for Grade 7. The analysis shows that the content standard that expected learners to investigate and extend geometric patterns fell under 'knowledge'. The corresponding DBE workbook activities also fell under 'knowledge'. This shows that the knowledge of geometric figures and of number systems is required in order to extend geometric patterns. The example that confirms 'full' level of agreement between content standards and DBE workbook activity has been extracted from the mathematics Grade 7 DBE workbook and has been set out below:

- Create the first three terms of the following patterns with matchsticks and then draw the patterns in your book.
  - Triangular pattern.

The assessment activity expected learners to apply their knowledge of triangular patterns to create the first three terms, hence, the cognitive level for this assessment activity fell under ‘knowledge’. Another content standard that expected learners to apply knowledge was the one that expected learners to investigate and extend numeric and geometric patterns using learners’ own creation patterns. The corresponding DBE workbook activity also fell under ‘knowledge’. This confirms that the cognitive level of the content standard that expected learners to investigate and extend patterns using learners’ own creation patterns had the same cognitive level as that of the DBE workbook activity on NGP. The example of aligned assessment activity to the content standard has been extracted from the mathematics Grade 7 DBE workbook and has been indicated below:

- Create your own sequence without a constant ratio.

The above example expects learners to demonstrate whether they have knowledge of a constant ratio before creating a sequence, since the pattern should be without a constant ratio, hence, classified under ‘knowledge’. However, the DBE workbook classified the same example as ‘problem solving’. This kind of discrepancy creates confusion in terms of classifying the assessment activities correctly according to cognitive levels. It is imperative that assessment activities be classified correctly in order to avoid confusion. Some of the content standards and the DBE workbook activities were classified under ‘knowledge’ and ‘routine procedures’. This shows that the content standards or the DBE workbook activities covers both ‘knowledge’ and ‘routine procedures’. The following examples confirm such a finding, where assessment activities corresponding to a content standard were classified under ‘knowledge’ and ‘routine procedures’.

- Describe the rule for each pattern.
    - 4,5,6,7,8

- Describe the rule for each pattern.
    - -6,-4,-2,0,2

The above assessment activities included patterns with constant difference. However, when analysing the two assessment activities, the first assessment activity shows that the pattern is growing by 1. This can be found by recalling knowledge of whole numbers, without applying a procedure to determine the constant difference, where the previous term is subtracted from the next term. Hence, the assessment activity is classified as ‘knowledge’. However, when comparing the first assessment activity with the second assessment activity, the second assessment activity may well require a procedure to determine the constant difference before describing the rule. Hence, classified the second assessment activity as ‘routine procedures’ while the first is classified as ‘knowledge’. However, the two assessment activities can still be classified as ‘routine procedures’, since a procedure can be applied to both in order to determine the constant difference before describing the rule.

Another assessment activity that confirms that assessment activities can be classified as either ‘knowledge’ or ‘routine procedures’, while corresponding to one content standard. An example has been extracted from mathematics Grade 7 DBE workbook activities on NGP and has been set out below:

- Describe the pattern.
    - 6,12,24,48,96
    - 7,42,252,1512

The first assessment activity above can be described through the use of knowledge of multiplication table (e.g. multiply the previous term by 2 to get the next term), while the second assessment activity might require a procedure to determine the constant ratio by dividing the next term by the previous term to be able to describe the pattern. Hence, the first assessment activity could fall under ‘knowledge’, while the second assessment activity could fall under ‘routine procedures’. However, the first assessment activity could also fall under ‘routine procedures’ since a procedure may also be applied through subtracting the previous term from the next term in order to describe the pattern. The two assessment activities confirm that assessment activities addressing one content standard may fall into different cognitive levels. Other assessment activities that fell on different cognitive levels but addressing same content standard that deals with patterns without constant difference nor constant ratio. The following example is extracted from DBE workbook for Grade 7.

- Describe the pattern and make a drawing to show the value of each term.
  - 8,10,13,17,22
  - -7,-1,11,29,53

The first assessment activity above could fall under 'knowledge', while the second assessment activity could fall under 'routine procedures'. This is concluded because the first assessment activity may well require 'knowledge' of whole numbers where the pattern shows that is growing by 1 starting from 2. Even without applying procedures of determining the difference, one can recognise how the pattern is growing using 'knowledge'. On the second assessment activity, one might be expected to apply a procedure to determine how the pattern grows. The two assessment activities address the same content standard but could well fall into different cognitive levels which are 'knowledge' and 'routine procedures'. Again, the first assessment activity could also fall under 'routine procedures' where a procedure of determining the difference before describing the pattern may be applied.

On the other hand, it was found that DBE workbook activities classified some activities as 'problem solving', when in fact they were not pitched at that level. The following example is a confirmation of the finding and has been extracted from the mathematics Grade 7 DBE workbook.

- Create your own sequence without a constant ratio.

The example above has been classified under 'problem solving' on the DBE workbook activities on NGP while it seems to fit well into 'knowledge'. Learners would require knowledge of a constant ratio before creating a pattern, since the pattern must be without a constant ratio. This indicates that learners should have knowledge of what a constant ratio is, in order to create the pattern. Once learners have knowledge of a constant ratio, they may be in a position to create a pattern without a constant ratio. According to Adams (2015) 'knowledge' questions are foundational cognitive skill and deals with the retention of specific, discrete pieces of information like facts and definitions. Again DBE (2011) describes 'knowledge' questions as those that use mathematical fact and appropriate mathematical vocabulary. The assessment activity required learners to create a sequence without a constant ratio and expects learners to use mathematical fact and appropriate mathematical vocabulary to be able to come up with such a sequence.

On the other hand, 'problem solving' is described as involving high order questions which often involve processes and may require breaking down of the problem into its constituents parts (DBE, 2011). Classifying assessment activities wrongly in terms of the cognitive levels, may cause confusion in terms of classifying assessment activities according to their cognitive levels. It is therefore suggested that correct classification be made to avoid inappropriate classification of assessment activities. It is also recommended that the cognitive levels be made clear to avoid such gaps. At times there is thin line between the cognitive levels, which made it difficult to classify the cognitive levels correctly. The level of agreement on the DoK consistency for Grade 7 was fully covered, since the cognitive levels of the content standards were the same as that of the DBE workbook activities.

- GRADE 8 DEPTH OF KNOWLEDGE CONSISTENCY

The depth of knowledge consistency was also explored in Grade 8 to check whether the cognitive levels of the content standards are consistent with the cognitive levels of the DBE workbook activities on NGP. This was done to verify if the cognitive levels of the two components are well aligned. Table 4.13 below shows the cognitive levels of the content standards on NGP for Grade 8.

Table 4. 13: Grade 8 cognitive level identified on NGP's content standards

Content standards on NGP		Cognitive levels identified
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.	Knowledge
	• not limited to sequences involving a constant difference or ratio.	• Knowledge • Routine procedures
	• of learner's own creation.	• Knowledge
	• represented in tables.	• Knowledge • Routine procedures
	• represented algebraically.	• Routine procedures
2. Describe and justify the general rules for observed relationships between numbers in own words or algebraic language.		• Knowledge • Routine procedures

Table 4.13 above shows the cognitive levels identified from the content standards on NGP for the mathematics Grade 8. The cognitive levels identified for the content standards were compared with the cognitive levels of the corresponding DBE workbook activities on NGP. Table 4.14 below shows the cognitive levels identified for the DBE workbook activities for the mathematics Grade 8.

Table 4. 14: Grade 8 cognitive levels identified on NGP's DBE workbook activities

Worksheet	Activity	Cognitive levels identified
WS 27a	1;2&4	Knowledge; routine procedures
WS 27a	3	Knowledge; routine procedures
WS 27a	5	Knowledge; routine procedures
WS 27a	PS a	Knowledge
WS 27a	PS b	Knowledge
WS 27b	1	Knowledge
WS 27b	2	Knowledge
WS 27b	3	Knowledge
WS 27b	4	Knowledge; routine procedures
WS 27b	5	Routine procedures
WS 27b	PS a	Knowledge; routine procedures
WS 27b	PS b	Knowledge

Table 4.14 above shows the cognitive levels of the DBE workbook activities on NGP for the mathematics Grade 8. The cognitive levels of the DBE workbook activities on NGP were compared with the cognitive level of the content standards. This was done to check whether the DBE workbook activities on NGP measured the same degree of the cognitive level of the corresponding content standards. Table 4.15 shows the comparison of cognitive levels identified on both the content standards and the DBE workbook activities on NGP for Grade 8.

Table 4. 15: Comparison of Grade 8 cognitive levels identified on NGP's content standards and DBE workbook activities for Grade 8

Content standards on NGP	**Cognitive levels identified on contents**	**Cognitive levels identified on DBE workbook activities**	**Scale of agreement (Full/acceptable/insufficient)**
1. Investigate and extend:- • Numeric patterns.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Geometric patterns/patterns in physical or diagrammatic form.	• Knowledge	• Knowledge	Full
• Patterns with constant difference.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns with constant ratio.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns with neither constant difference nor ratio.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns from learners own creation.	• Knowledge	• Knowledge	Full
• Patterns represented in tables.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns represented algebraically.	• Routine procedures	• Routine procedures	Full
2. Describe general rule of patterns in own words or in algebraic language.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
Overall level of agreement			**Full**

Table 4.15 above shows the comparison of the cognitive levels identified from both the content standards and the DBE workbook activities on NGP for Grade 8. From the analysis, the cognitive level of the DBE workbook activities that required learners to investigate and extend geometric patterns fell under 'knowledge'. The same cognitive level was identified on the corresponding content standard as 'knowledge'. The following example confirms the finding and has been extracted from the mathematics Grade 8 DBE workbook.

- Draw the first three terms of a triangular number pattern (as you did for a hexagon using matches in question 1).

The assessment activity required learners to apply knowledge of triangular pattern to be able to draw the first three terms. Hence, the assessment activity fell under 'knowledge'. However, the DBE workbook classified the same activity as ‘problem solving’. It is imperative that assessment activities be classified correctly in terms of cognitive levels to avoid confusion for both teachers and learners in the classroom. The cognitive level of the DBE workbook activities that required learners to deal with patterns with constant difference, constant ratio and neither constant difference nor constant ratio, had a cognitive level of ‘knowledge’ and ‘routine procedures’. Similarly, the same cognitive levels were identified on the corresponding content standards. The following example indicates such a finding and has been extracted from the mathematics Grade 8 DBE workbook activities on NGP.

- What is the constant difference between the consecutive terms?.
    - 3,5,7,9
    - 8,2,-4,-10

Learners may apply knowledge of odd numbers on the first assessment activity in order to come up with the constant difference between the consecutive terms, even without applying a procedure. However, the second assessment activity could require a procedure of subtracting the previous term from the next term in order to ascertain the constant difference between the consecutive terms. However, the first assessment activity could also be classified under ‘routine procedures’, since the procedure of subtracting the previous term from the next term can be applied in order to get the constant difference. Other examples of assessment activities addressing one content standard but falling on different cognitive levels have been indicated below and have been extracted from the Grade 8 DBE workbook.

- What is the constant ratio between the consecutive terms?.
    - 3,9,27,81
    - 2, -8, 32, -128

Learners may apply ‘knowledge’ of multiplication or exponential numbers in order to come up with the constant ratio on the first assessment activity, for example, 3x1, 3x3, 3x3x3, 3x3x3x3 =3^1, 3^2, 3^3, 3^4. Hence, classified under ‘knowledge’. On the second assessment activity, learners may apply a procedure to determine the constant ratio by dividing the next term by the previous term on the second assessment activity. The example given above shows that the assessment activities addressing the same content standard can be assessed using different cognitive levels, as analysed on the content standards. However, the first assessment activity can also be classified as 'routine procedures', since procedure could be applied in order to find the constant ratio.

The DBE workbook activities that required learners to create their own patterns were found to have the common cognitive level with the corresponding content standard, which is 'knowledge'. The following is an example extracted from the mathematics Grade 8 DBE workbooks to confirm the finding.

- Draw the matchsticks to make the next pattern in a sequence of hexagons.

(**See Figure 4.3 above**)

The assessment activity required knowledge of hexagons to be able to draw the next pattern. This assessment activity has the same cognitive level as that of the corresponding content standard, hence the two components are fully aligned. Webb (1997) highlights that the content standards are cognitively aligned to the assessment when they have the same cognitive level. The DBE workbook activities that required learners to extend patterns in tables had the same cognitive levels as the corresponding content standard which are 'knowledge' and 'routine procedures'. The following is an example of such a finding and has been extracted from the mathematics Grade 8 DBE workbook.

- Complete the table. Determine the term value as asked.

Position	0	1		3	4	n
Value of the term		2		6	8	

- Complete the table. Determine the term value as asked

Position	5	15	25	35	n
Value of the term	12	22			

The cognitive levels identified for the two assessment activities are 'knowledge' and 'routine procedures'. Learners may apply 'knowledge' of whole numbers and even numbers to be able to complete the first table. On the other hand, learners may apply a procedure to determine the constant difference between the numbers on the second table. The constant difference may consequently help to get a general rule which could finally assist in completing the second table. Hence, the two assessment activities were classified on different cognitive levels as ‘knowledge’ and ‘routine procedures’ for the first, and the second assessment activities respectively. The fact that the first table can be completed through the application of knowledge of whole numbers and even numbers. It does not mean that a simple procedure cannot be applied. This means that the same assessment activity can apply a simple procedure in order to complete the table, hence the first assessment activity may fall under ‘knowledge’ and ‘routine procedures’.

Correspondingly, the DBE workbook activities that needed learners to extend patterns represented in algebraic language was found to have the same cognitive level as that of the corresponding content standards, which is ‘routine procedures’. The following example confirms such a finding that the DBE workbook activities that required learners to investigate and extend NGP represented algebraically, fell under ‘routine procedures’.

- Draw and complete your own tables using the following information:
    - $8(n) + 3$

Term						n
Value of the term						

Learners are expected to apply a procedure to be able to come up with the values of the terms by substituting the term number and simplify the expression as part of the ‘routine procedures’. e.g. 8(1)+3=11, 8(2)+3=19). This indicates that some of the DBE workbook activities on NGP for Grade 8 have been developed in line with the content standards. Lastly, the DBE workbook activities that needed learners to describe the general rules of patterns were found to have the same cognitive level as that of the corresponding content standards. The cognitive levels identified for both components are ‘knowledge’ and ‘routine procedures’. This indicates that the DBE workbook activities on NGP were developed with the same cognitive levels as the corresponding content standards. Therefore, the level of agreement for the depth of knowledge consistency for Grade 8 was fully covered. The cognitive levels of the content standards were the same as the cognitive levels of the DBE workbook activities on NGP.

However, there were DBE workbook activities in Grade 8 that were classified under ‘problem’ solving’, but when analysed, they were found to be falling under ‘knowledge’ and ‘routine procedures’. This has a capacity to create confusion when assessing the level of complexity within the assessment activities. It is important that the assessment activities be pitched at the appropriate cognitive level in line with the CAPS. It is imperative for assessment activities to be labelled correctly in order to avoid confusion in terms of cognitive levels in the classroom. An example of the DBE workbook activities that were labelled ‘problem solving’ when in fact they did not fall under that cognitive level has been extracted from Grade 8 DBE workbook as indicated below.

- If the constant ratio is -8, what could a sequence of numbers be?.
- Draw diagrams to illustrate the arithmetic patterns in question 2a and d and the geometric patterns in 5a and d.
    - (2a). 3, 9, 27, 81

The first assessment activity above requires knowledge of constant ratio and a procedure to develop a sequence, which needs one to multiply the previous term by the constant ratio to get the next term (e.g.1; 1x-8, (1x-8)x-8;... where the sequence will be: 1; -8, 64;...). Therefore the assessment activity does not qualify to be ‘problem solving’, but rather as ‘routine procedures’. Again, the second assessment activity above was also labelled ‘problem solving’ when in fact it is not. Making a drawing to illustrate the arithmetic and geometric patterns when a sequence is given does not qualify to be ‘problem solving’. This is concluded since the knowledge of physical or diagrammatic patterns is needed with the use of number sequence to make a drawing. Hence, the assessment activities fell under ‘knowledge’ not ‘problem solving’. Figure 4.4 below shows the researcher’s example of how the second assessment activity above can be illustrated.

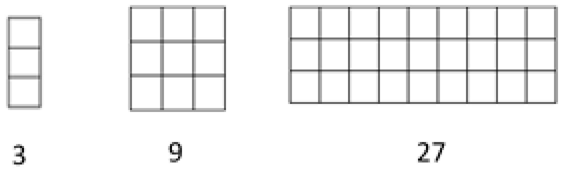


Figure 4. 4: Researcher’s example illustration of arithmetic pattern

Figure 4.4 confirms that the assessment activity labelled ‘problem solving’ does not qualify to fall under ‘problem solving’. DBE (2011) highlights that a problem solving may require a higher order understanding and the ability to break down the problem into its constituents parts. Hence, the activity given on the DBE workbook does not qualify to be ‘problem solving’. It is important to label the assessment activities correctly when giving assessments on learning materials in order to give correct guidance. Hence, the level of agreement on the DoK consistency on mathematics Grade 8 was fully covered.

❖ GRADE 9 DEPTH OF KNOWLEDGE CONSISTENCY

The depth of knowledge consistency was also explored in Grade 9, to check whether the DBE workbook activities are pitched at the same cognitive levels with the corresponding content standards. Table 4.16 below shows the cognitive levels identified from the content standards in Grade 9 on NGP.

Table 4. 16: Grade 9 cognitive level identified on NGP's content standards

Content standards on NGP		Cognitive levels identified
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.	• Knowledge
	• not limited to sequences involving a constant difference or ratio.	• Knowledge • Routine procedures
	• of learner's own creation.	• Knowledge
	• represented in tables.	• Knowledge • Routine procedures
	• represented algebraically.	• Routine procedures
2. Describe and justify the general rules for observed relationships between numbers in own words or algebraic language.		• Knowledge • Routine procedures

Table 4.16 above shows the cognitive levels identified for the mathematics Grade 9 content standards on NGP. The cognitive levels identified on the content standards were compared with the cognitive levels identified on the DBE workbook activities on NGP. Table 4.17 below shows the cognitive levels identified for the DBE workbook activities on NGP for the mathematics Grade 9.

Table 4. 17: Grade 9 cognitive level identified on NGP's DBE workbook activities

Worksheet	Activity	Cognitive levels identified
WS 27	1;2&3	Knowledge; routine procedures
WS 27	4	Knowledge; routine procedures
WS 27	5	Knowledge; routine procedures
WS 27	PS	Knowledge
WS 28	1	Knowledge
WS 28	2&3	Routine procedures
WS 28	PS	Knowledge

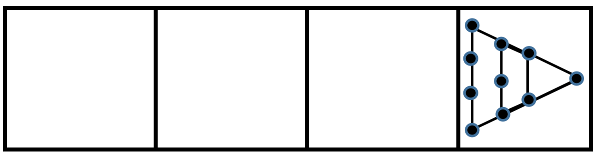
Table 4.17 above shows the cognitive levels of the DBE workbook activities on NGP for Grade 9. The cognitive levels of the DBE workbook activities were compared with the cognitive levels of the content standards. Table 4.18 below is a comparison of the cognitive levels identified on the content standards and the DBE workbook activities for mathematics Grade 9.

Table 4. 18: Comparison of Grade 9 cognitive levels identified on NGP's content standards and DBE workbook activities

Content standards on NGP	**Cognitive levels identified on content standards**	**Cognitive levels identified on DBE workbook activities**	**Scale of agreement (Full/acceptable/ insufficient)**
1. Investigate and extend:- Numeric patterns.	• Knowledge Routine procedures	• Knowledge Routine procedures	Full
• Geometric patterns/patterns in physical or diagrammatic form.	• Knowledge	• Knowledge	Full
• Patterns with constant difference.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns with constant ratio.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns with neither constant difference nor ratio.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns from learners own creation.	• Knowledge	• Knowledge	Full
• Patterns represented in tables.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
• Patterns represented algebraically.	• Routine procedures	• Routine procedures	Full
2. Describe general rule of patterns in own words or in algebraic language.	• Knowledge • Routine procedures	• Knowledge • Routine procedures	Full
Overall level of agreement			**Full**

Table 4.18 above shows the comparison of the cognitive levels of the content standards and the DBE workbook activities on NGP for mathematics Grade 9. The analysis shows that the cognitive level of the DBE workbook activities that required learners to extend geometric patterns or patterns in physical or diagrammatic form fell under 'knowledge'. The same cognitive level was identified on the corresponding content standard. The following example illustrates the fact that the DBE workbook activities and the content standard had the same cognitive level where learners were expected to investigate and extend geometric patterns.

- Create and complete the following geometric patterns.
  - Triangle.



The assessment activity fell under ‘knowledge’ since learners may be expected to apply their knowledge of triangular number patterns to be able to complete the table. This is in line with the cognitive level of the corresponding content standard. The assessment activities that required learners to extend patterns that involve patterns with constant difference, constant ratio, and neither constant difference nor constant ratio, was pitched at the same cognitive level with the corresponding content standard. The two components were classified under ‘knowledge’ and ‘routine procedures’. This means that some of the assessment activities were classified as ‘knowledge’ while others were classified as ‘routine procedures’. The following example illustrate the finding where assessment activities fell under ‘knowledge’, while others fell under ‘routine procedures’, but addressing the same content standard.

Investigate and extend patterns with constant difference.

- Describe the pattern by giving the rule and then extend it with three more terms.
  - 2,4,6,8,10
  - -1, 5, 11, 17

The first assessment activity may fall under ‘knowledge’, since knowledge of even numbers can be applied in order to extend the pattern with three more terms. The second assessment activity may fall under ‘routine procedures’, since procedure may be applied by subtracting the previous term from the next term to determine the common difference before extending the pattern three more terms. However, the first assessment activity may also be classified as ‘routine procedures’ since a procedure may be applied to get the constant difference before extending the pattern. Another assessment activity that fell under ‘knowledge’ and ‘routine procedures’, which involved constant ratio has been extracted from the Grade 9 DBE workbook and is indicated below.

Investigate and extend patterns with constant ratio.

- Describe the pattern by giving the rule and then extend it by three terms.
  - 2,4,8,16,32,64
  - 25, 5, 1, 0,2, 0,04

The first assessment activity may require application of knowledge of square numbers in order to extend the pattern, for example, 2^1, 2^2, 2^3, 2^4, 2^5, 2^6. Hence this is classified as ‘knowledge’. The second assessment activity may require a procedure to determine the constant ratio which may be used to extend the pattern and hence, classified as ‘routine procedures’. On the other hand, a procedure may also be applied on the first assessment activity to determine the constant ratio before extending the pattern. This confirms that an assessment activity may be solved from differently cognitive levels. Hence, it is critical for cognitive levels to be clear in order to provide proper guidelines on assessments.

The DBE workbook activities that expected learners to create their own patterns had a cognitive level that fell under ‘knowledge’. The corresponding content standard was also pitched at the same cognitive level, which is ‘knowledge’. An example of such finding is extracted from the mathematics Grade 9 DBE workbook on NGP and has been indicated below:

- Create your own sequence as follows.
    - Constant difference between the consecutive terms.
    - Constant ratio between the consecutive terms.
    - Neither a constant difference nor a constant ratio.

The assessment activities required learners to apply ‘knowledge’ of different patterns involving constant difference, constant ratio and without constant difference nor constant ratio to create a pattern. However, the DBE workbook classified these assessment activities as ‘problem solving’. According to DBE (2011), ‘problem solving’ questions are questions that require a high level of understanding and may require the breaking down of a question into its constituents parts. From the analysis, the assessment activities do not require a high level of understanding and breaking down of question. Hence, the assessment activity does not fall under ‘problem solving’. The assessment activities that required learners to extend patterns represented in tables fell under ‘knowledge’ and ‘routine procedures’. This shows that some of the assessment activities fell under ‘knowledge’, while others fell under ‘routine procedures’. The following example shows the assessment activities which address same content standard but classified on different cognitive levels. This has been extracted from the mathematics Grade 9 DBE workbook.

- Complete the table.

Position in sequence	2	4	6	8	10	n
Term	-10	-8	-6	-4		

- Determine the 10th and nth position of the term using a table and number sentence.

Position in sequence	-5	0	5	10	15	n
Term	-126	-1	124		374	

The first assessment activity above may be responded to through the application of knowledge of even numbers, without applying a procedure. For example the position in the sequence increases by 2 and the term also increases by 2. Without applying any procedure, one may be able to complete the table. The second assessment activity may require an application of a procedure to determine the constant difference between the terms. For example, -1-(-126)=125 and 124-(-1)=125. This shows that the patterns increase by 125. The two assessment activities are addressing the same content standard, but fall under different cognitive levels. The first one may fall under 'knowledge' while the second one may fall under 'routine procedures'. Nevertheless, a procedure may also be applied on the first assessment activity in order to complete the table, which will then qualifies it to be 'routine procedures'. Therefore, the assessment activities may fall under different cognitive levels but addressing one content standard.

The DBE workbook activities that required learners to extend a pattern represented in algebraic language fell under 'routine procedures'. The same cognitive level was identified from the corresponding content standards, i.e. 'routine procedures'. The following example shows the significant alignment between the content standard and the DBE workbook activities on NGP for mathematics Grade 9.

- Use the rule to complete each table.
  - Rule: $y = 10(x + 2)$

x	-3	5	13	21	29	37
y						

The assessment activity requires learners to apply the procedure of substituting the values of x and then simplify to get the values of y. The assessment activity's cognitive level is in line with the corresponding content standard which is 'routine procedures'. According to Webb (1997), the assessment activity is cognitively aligned to the content standard. The DBE workbook activities, that needed learners to describe the pattern by giving the rule in own words or in algebraic language fell under cognitive levels 'knowledge' and 'routine procedures'. The corresponding content standard was also identified and fell under 'knowledge' and 'routine procedures'. This shows that the cognitive level of the content standard is the same as the cognitive level of the DBE workbook activities on NGP. This qualifies the level of agreement of the DoK for mathematics Grade 9 to be fully covered. This conclusion was made based on the same cognitive levels of the content standards and DBE workbook activities on NGP. Webb (1997) highlights that the content standards and the assessment activities should have the same cognitive levels in order for the two components to be well aligned.

4.3.3. Range of Knowledge Correspondence

This category was employed to determine the breadth of knowledge covered in terms of the wide range of patterns covered by the content standards and DBE workbook activities on NGP. This was done to verify consistency in terms of the range of patterns covered by both components. The range of knowledge correspondence differs from the categorical concurrence, since its focus is on the range of patterns covered, while categorical concurrence focused on the content covered. The unit of comparison on the range of knowledge consistency focused on the ranges of patterns covered by the content standards and the DBE workbook activities.

The scale of agreement between the content standards and the DBE workbook activities included 'full', 'acceptable' and 'insufficient'. The level of agreement, 'full' was applied when the full range of patterns on content standards was covered by the assessment activities. Moreover, 'acceptable' level of agreement was applied where nearly all the range of patterns for content standards were covered by the assessment activities. Further, 'insufficient' was applied where the major concepts on the content standards were excluded on the assessment activities. Nevertheless, the researcher thinks there is a gap on the scale of agreement presented by Webb (1997), since it does not cover a situation where the assessment measures the range of patterns beyond the scope of the content standards. The researcher extended the scale of agreement to cover ‘not applicable’, where assessment measured the ranges of patterns beyond the scope of the content standards.

- GRADE 7 RANGE OF KNOWLEDGE CORRESPONDENCE

The range of knowledge correspondence was explored in Grade 7 to check the consistency of the ranges of patterns covered in mathematics Grade 7 content standards and the DBE workbook activities on NGP. Table 4.19 below shows the ranges of patterns identified from the content standards on NGP for mathematics Grade 7.

Table 4. 19: Grade 7 range of patterns identified on NGP’s content standards

<table>
<tr><th colspan="2">Content standards on NGP</th><th>Ranges of patterns identified</th></tr>
<tr><td rowspan="7">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td><td rowspan="2">• represented in physical or diagram form.</td><td>• Numeric patterns.</td></tr>
<tr><td>• Geometric patterns/ physical/ diagrammatic.</td></tr>
<tr><td rowspan="3">• not limited to sequences involving a constant difference or ratio.</td><td>• Patterns involving constant difference.</td></tr>
<tr><td>• Patterns involving constant ratio.</td></tr>
<tr><td>• Patterns with nether a constant difference nor ratio.</td></tr>
<tr><td>• of learner’s own creation.</td><td>• Patterns from learners’ own creation.</td></tr>
<tr><td>• represented in tables.</td><td>• Patterns represented in tables.</td></tr>
<tr><td colspan="2">2. Describe and justify the general rules for observed relationships between numbers in own words.</td><td>• Numeric patterns.</td></tr>
</table>

Table 4.19 above shows the ranges of patterns identified for the content standards on NGP for the Grade 7. These ranges of patterns were compared with the ranges of patterns identified for the DBE workbook activities on NGP for the Grade 7. Table 4.20 below shows the ranges of patterns identified on the DBE workbook activities on NGP for the mathematics Grade 7.

Table 4. 20: Grade 7 ranges of patterns identified on NGP's DBE workbook activities

Worksheet	Activity	Ranges of patterns identified
WS 65	1	• Patterns represented on number lines.
WS 65	2	• Numeric patterns & patterns with constant difference.
WS 65	S	• Patterns from own creation.
WS 66	1	• Numeric patterns & patterns with constant ratio.
WS 66	PS	• Patterns from own creation.
WS 67	1	• Numeric patterns & patterns represented on number lines.
WS 67	PS	• Patterns from own creation.
WS 68	1	• Patterns represented on tables.
WS 68	2	• Patterns represented on tables.
WS 68	PS	• Patterns in context.
WS 69	1	• Numeric patterns, patterns with constant difference, patterns with neither constant difference nor a constant ratio & patterns with integers.
WS 69	PS	• Patterns in context.
WS 70	1	• Geometric patterns & patterns represented in tables.
WS 70	2	• Patterns with constant difference & patterns with constant ratios.
WS 70	PS	• Geometric pattern.
WS 71a	1	• Numeric patterns, patterns with constant difference, patterns represented on number lines & patterns represented algebraically.
WS 71b	PS	• Patterns represented algebraically.
WS 114	1	• Patterns represented on number lines.
WS114	2&3	• Numeric patterns, patterns with whole numbers, patterns with integers, patterns with constant difference & patterns with constant ratio.
WS 114	PS	• Patterns in context.
WS 115	1	• Numeric patterns, patterns with drawing & patterns with neither a constant difference nor a constant ratio.
WS 115	2&3	• Patterns represented in tables.
WS 115	PS	• Patterns in context.
WS 116	1	• Numeric patterns, patterns with constant difference, patterns with whole numbers & patterns with integers.
WS 116	PS	• Patterns in context.
WS 117a	1	• Numeric patterns, patterns on number line, patterns in tables, patterns represented algebraically.
WS 117b	PS	• Numeric patterns, patterns with integers.

Table 4.20 shows the ranges of patterns identified in the DBE workbook activities on NGP for the mathematics Grade 7. These ranges of patterns were compared with the ranges of patterns identified from the content standards for the mathematics Grade 7. Table 4.21 below shows the comparison of the range of patterns identified from both the content standards and the DBE workbook activities for Grade 7.

Table 4. 21: Grade 7 ranges of patterns identified on NGP's content standards and DBE workbook activities

Ranges of patterns identified on content standards	Ranges of patterns identified on DBE workbook activities	Scale of agreement (Full/acceptable/in sufficient/ not applicable
• Numeric patterns.	• Numeric patterns.	Full
• Geometric patterns/patterns in physical or diagrammatic form.	• Geometric patterns.	Full
• Patterns with constant difference.	• Patterns with constant difference.	Full
• Patterns with constant ratio.	• Patterns with constant ratio.	Full
• Patterns with neither constant difference nor ratio.	• Patterns with neither constant difference nor a constant ratio.	Full
• Patterns from learners' own creation.	• Patterns from own creation.	Full
• Patterns represented in tables.	• Patterns represented on tables.	Full
	• Patterns represented algebraically.	Not applicable
	• Patterns represented on number lines.	Not applicable
	• Patterns in context.	Not applicable
	• Patterns with integers.	Not applicable
	• Patterns with whole numbers.	Not applicable
Overall level of agreement		**Acceptable**

Table 4.21 above shows the ranges of patterns identified from the content standards and DBE workbook activities on NGP for the mathematics Grade 7. From the analysis, all ranges of patterns prescribed on the content standards have been covered by the DBE workbook activities on NGP for Grade 7. However, other ranges of patterns covered by the DBE workbook activities were beyond the scope of the content standards. Again, the teaching guidelines outlined the ranges of patterns to be achieved in mathematics Grade 7, but not outlined on the content standards. According to the teaching guidelines, the ranges of patterns to be covered in the mathematics Grade 7, include: patterns with integers, square numbers, cubic numbers, whole numbers, common fractions, numbers in exponential form, and decimal fractions. It would have been better if these ranges of patterns had been mentioned on the content standards

to guide the developers of assessments and learning materials as well as the teachers.

It is important that content standards indicate the ranges of patterns to be covered, rather than indicating the ranges of patterns on the teaching guidelines only. The implication is that teachers and developers of assessments and learning materials might miss this important information as a guideline. Hence, it is recommended that the ranges of patterns be part of the content standards, rather than outlining them on the teaching guidelines. Again, the teaching guidelines should clarify what is on the content standards, rather than outlining new concepts. This can be addressed when the curriculum is reviewed. Since this study focused on the ranges of patterns covered in the content standards, the analysis was also based on the content standards rather than the teaching guidelines. The following are the examples of the ranges of patterns covered on the DBE workbook activities, but not prescribed on the content standards, and have been extracted from the mathematics Grade 7 DBE workbook.

Range of patterns covered by DBE workbook activities but not prescribed on the content standards.

Patterns involving algebraic language.

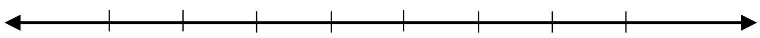
- Describe the sequence in different ways using the template provided.
    - -1, 2, 5, 8
    - Where n is the position of the term.

nth term:

Patterns represented on number lines.

- Describe the pattern and draw a number line to show each.
    - 8, 10, 14, 20, 28

- Describe the sequence in different ways using the template provided.



- Describe each pattern.

(**See Figure 4.1**)

Patterns in context.

- Thabelo is building a model house from matches. If he uses 400 matches in the first section. 550 in the second and 700 in the third section. How many matches will he need to complete the fourth section, if the pattern continues?.

- Tshepo earns R25 per week for washing his father's motor car. If he saves R5,50 the first week, R7,50 the second week and R9,50 the third week, how much will he save in the fourth week if the pattern continues?.

Patterns with integers.

- Describe the rule for each pattern.
    - -20, -15, -10, -5, 0

Patterns with whole numbers.

- Describe the rule for each pattern.
    - 4,5,6,7,8

These indicate that some of the DBE workbook activities did not cover the ranges of patterns prescribed by the content standards. The implications could be that teachers may teach out of scope content which could temper with learners' cognition and time allocation. This creates discrepancies between the ranges of patterns prescribed on the content standards and DBE workbook activities. However, the range of patterns that involve integers and whole numbers have been outlined in the teaching guidelines and not on the content standards. This creates gaps since this study focused on the content standards rather than the teaching guidelines. The patterns that are represented on number lines can be best suited in the foundation phase and intermediate phase as number lines are emphasised as calculation techniques at that level. Again, the patterns represented in algebraic language are best suited in the Grade 8 and Grade 9 as stipulated on the content standards for Grade 8 and Grade 9. It is important that assessment activities be suited to the learners' relevant grades and complexity.

Therefore, the level of agreement for the range of knowledge correspondence between content standards and DBE workbook activities on NGP for Grade 7 was acceptable. Webb (1997) emphasises that the criterion on range of knowledge correspondence is acceptable, when nearly the whole range of knowledge is covered by the assessment.

❖ GRADE 8 RANGE OF KNOWLEDGE CORRESPONDENCE

The range of knowledge correspondence was also explored in Grade 8 to see whether the ranges of patterns covered by the content standards are the same as the ranges of patterns covered by the DBE workbook activities on NGP. Table 4.22 below shows the ranges of patterns identified from the content standards on NGP for Grade 8.

Table 4. 22: Grade 8 range of patterns identified on NGP’s content standards

<table>
<tr><th colspan="2">Content standards on NGP</th><th>Ranges of patterns identified</th></tr>
<tr><td rowspan="8">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td><td rowspan="2">• represented in physical or diagram form.</td><td>• Numeric patterns.</td></tr>
<tr><td>• Geometric patterns/ physical/ diagrammatic.</td></tr>
<tr><td rowspan="3">• not limited to sequences involving a constant difference or ratio.</td><td>• Patterns involving constant difference.</td></tr>
<tr><td>• Patterns involving constant ratio.</td></tr>
<tr><td>• Patterns with nether a constant difference nor ratio.</td></tr>
<tr><td>• of learner’s own creation.</td><td>• Patterns from learners own creation.</td></tr>
<tr><td>• represented in tables.</td><td>• Patterns represented in tables.</td></tr>
<tr><td>• Represented algebraically.</td><td>• Patterns with algebraic language.</td></tr>
<tr><td colspan="2">2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.</td><td>• Numeric patterns.</td></tr>
</table>

Table 4. 22 above shows the ranges of patterns identified from the content standards on NGP for the mathematics Grade 8. These ranges of patterns identified from the content standards were compared with the ranges of pattern identified from the DBE workbook activities. This was done to see whether the same ranges of pattern are covered on both components. Table 4.23 below shows the range of patterns identified from the DBE workbook activities on NGP for the mathematics Grade 8.

Table 4. 23: Grade 8 ranges of patterns identified on NGP's DBE workbook activities

Worksheet	Activity	Ranges of patterns identified
WS 27a	1;2&4	• Numeric patterns, patterns with constant difference, patterns with constant ratio, patterns with integers & patterns with whole numbers.
WS 27a	3	• Patterns without constant difference nor ratio.
WS 27a	5	• Pattern represented in tables.
WS 27a	PS a	• Patterns from own creation.
WS 27a	PS b	• Geometric patterns.
WS 27b	1	• Geometric patterns.
WS 27b	2	• Geometric patterns.
WS 27b	3	• Pattern represented in tables.
WS 27b	4	• Pattern represented in tables.
WS 27b	5	• Patterns represented algebraically & pattern represented in tables.
WS 27b	PS a	• Geometric patterns & pattern represented in tables.
WS 27b	PS b	• Geometric patterns.

Table 4.23 above shows the ranges of patterns identified from the DBE workbook activities on NGP for the Grade 8. These range of patterns were compared with the ranges of patterns identified from the content standards. Table 4.24 below shows the comparison between the ranges of patterns identified from the content standards and DBE workbook activities.

Table 4. 24: Comparison of Grade 8 ranges of patterns identified on NGP's content standards and DBE workbook activities

Ranges of patterns identified on content standards	**Ranges of patterns identified on DBE workbook activities**	**Scale of agreement (Full/acceptable/in sufficient/ not applicable**
• Numeric patterns.	• Numeric patterns.	Full
• Geometric patterns/patterns in physical or diagrammatic form.	• Geometric patterns.	Full
• Patterns with constant difference.	• Patterns with constant difference.	Full
• Patterns with constant ratio.	• Patterns with constant ratio.	Full
• Patterns with neither constant difference nor ratio.	• Patterns without constant difference nor ratio.	Full
• Patterns from learners own creation.	• Patterns from own creation.	Full
• Patterns represented in tables.	• Pattern represented in tables.	Full
• Patterns represented algebraically.	• Patterns represented algebraically.	Full
	• Patterns with integers.	Not applicable
	• Patterns with whole numbers.	Not applicable
Overall level of agreement		**Acceptable**

Table 4.24 above shows the comparison of the ranges of patterns identified from the content standards and the DBE workbook activities on NGP for the mathematics Grade 8. The comparison shows that all ranges of patterns identified from the content standards are covered on the mathematics Grade 8 DBE workbook activities on NGP. This may have a positive impact in the mathematics classroom in terms of instruction and assessment, since the same ranges of patterns have been addressed in the DBE workbook activities on NGP and the content standards. Teachers who are using DBE workbooks to teach may be in a position to transfer expected content standards into the classroom, since same range of patterns is addressed on the DBE workbook activities on NGP and the content standards.

This indicates that the DBE workbook activities measured the ranges of patterns prescribed on the content standards. On the other hand, the DBE covered the range of patterns beyond the scope of the content standards, hence the level of agreement in those categories is ‘not applicable’. A gap has been identified between content standards and the teaching guidelines. Some of the ranges of patterns have been outlined on the teaching guidelines and not outlined on the content standards. This creates a serious gap in terms of providing guidelines on the ranges of patterns to be covered.

In fact, the teaching guidelines should clarify what is on the content standards rather than adding new and important information. According to DBE (2011), the range of patterns expected to be covered by the mathematics Grade 8, which have been outlined on the teaching guidelines are: the ranges of patterns to be extended from Grade 7 to cover patterns with multiplication and division with integers and numbers in exponential form. It would have been better if the ranges of patterns were outlined on the content standards rather than being outlined on the teaching guidelines only. This was going to clarify the progression of content between the grades. This is raised since the content standards on NGP for Grade 8 and Grade 9 do not show any content progression. Actually, both grades seem to be covering the same content, if the teaching guidelines are not consulted. Hence, the researcher recommends that the range of patterns should be outlined on the content standards to provide clear guidelines in terms of content progression and the range of patterns to be taught in different grades in the senior phase.

Therefore, the level of agreement for the range of knowledge correspondence between the content standards and the DBE workbook activities is acceptable in the mathematics Grade 8. This is confirmed since nearly all the ranges of patterns were covered by both components: content standards and DBE workbook activities.

❖ GRADE 9 RANGE OF KNOWLEDGE CORRESPONDENCE

The range of knowledge correspondence was also explored in Grade 9, to check if the range of patterns prescribed on the content standards are covered on the DBE workbook activities on NGP. Table 4.25 shows the ranges of patterns identified on the content standards on NGP for the mathematics Grade 9.

Table 4. 25: Grade 9 ranges of patterns identified on NGP's content standards

Content standards on NGP		Ranges of patterns identified
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.	• Numeric patterns.
		• Geometric patterns/physical/diagrammatic.
	• not limited to sequences involving a constant difference or ratio.	• Patterns involving constant difference.
		• Patterns involving constant ratio.
		• Patterns with nether a constant difference nor ratio.
	• of learner's own creation.	• Patterns from learners own creation.
	• represented in tables.	• Patterns represented in tables.
	• represented algebraically.	• Patterns with algebraic language.
2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.		• Numeric patterns.

Table 4. 25 above shows the ranges of patterns identified from the content standards on NGP for the mathematics Grade 9. These ranges of patterns were compared with the ranges of patterns identified from the DBE workbook activities on NGP for the mathematics Grade 9. Table 4.26 below shows the range of patterns identified from the DBE workbook activities on NGP for the mathematics Grade 9.

Table 4. 26: Grade 9 ranges of patterns identified on NGP's DBE workbook activities

Worksheet	Activity	Ranges of patterns identified
WS 27	1;2&3	• Numeric patterns, patterns with constant difference, patterns with constant ratio, patterns with neither constant difference nor a constant ratio, patterns with whole numbers, patterns with integers, patterns with common fractions & patterns with decimal fractions.
WS 27	4	• Patterns represented in tables.
WS 27	5	• Patterns represented in tables.
WS 27	PS	• Patterns from own creation.
WS 28	1	• Geometric patterns.
WS 28	2&3	• Patterns represented in tables, patterns represented algebraically.
WS 28	PS	• Patterns represented algebraically, patterns represented in tables.

Table 4.26 above shows the ranges of patterns identified from the DBE workbook activities on NGP for the mathematics Grade 9. The ranges of patterns identified from the content standards and the DBE workbook activities on NGP for the Grade 9 were compared to see if same ranges of patterns have been covered. Table 4.27 below shows the comparison of the ranges of patterns identified from the content standards and the DBE workbook activities on NGP.

Table 4. 27: Grade 9 ranges of patterns identified on NGP's content standards and DBE workbook activities

Ranges of patterns identified on content standards	Ranges of patterns identified on DBE workbook activities	Scale of agreement (Full/acceptable/ insufficient/ not applicable
• Numeric patterns.	• Numeric patterns.	Full
• Geometric patterns/patterns in physical or diagrammatic form.	• Geometric patterns.	Full
• Patterns with constant difference.	• Patterns with constant difference.	Full
• Patterns with constant ratio.	• Patterns with constant ratio.	Full
• Patterns with neither constant difference nor ratio.	• Patterns with neither constant difference nor a constant ratio.	Full
• Patterns from learners' own creation.	• Patterns from own creation.	Full
• Patterns represented in tables.	• Patterns represented in tables.	Full
• Patterns represented algebraically.	• Patterns represented algebraically.	Full
	• Patterns with whole numbers.	Not applicable
	• Patterns with integers.	Not applicable
	• Patterns with common fractions.	Not applicable
	• Patterns with decimal fractions.	Not applicable
Overall level of agreement		**Acceptable**

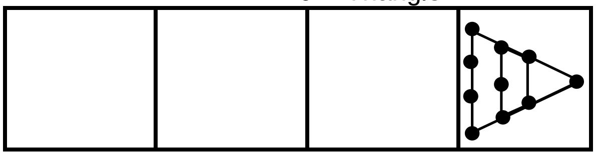
Table 4.27 above shows the comparison of the ranges of patterns identified from both the content standards and the DBE workbook activities on NGP for the mathematics Grade 9. All the ranges of patterns prescribed on the content standards were covered on the DBE workbook activities on NGP for the mathematics Grade 9. This indicates that the mathematics Grade 9 DBE workbook activities were developed in line with the content standards. However, the same challenge raised in Grade 7 and Grade 8 where ranges of patterns were outlined in the teaching guidelines also appear in Grade 9. The challenge is that, some of the ranges of patterns are not outlined on the content standards but rather outlined on the teaching guidelines. This creates gaps in terms of providing guidelines on which patterns to be covered in the mathematics Grade 9. And this important information might be missed by many teachers and the developers of learning materials and assessment. Examples of DBE workbook activities aligned to the content standards are extracted from mathematics Grade 9 DBE workbook. The examples are as follows:

Numeric patterns.

- Describe the pattern by giving the rule and then extend it with three more terms.
  - 1,5,9,13,17

Geometric patterns.

- Create and complete the following geometric patterns.
  - Triangle



Patterns with constant difference.

- Describe the pattern by giving the rule and then extend it with three more terms.
  - 15,12,9,6,3

Patterns with constant ratio.

- Describe the pattern by giving the rule and then extend it with three more terms.
  - 5,-20,80,-320,1280

Patterns with neither constant difference nor constant ratio.

- Describe the pattern by giving the rule and then extend it with three more terms.
  - 1,5,13,29,61,125

Patterns represented in tables.

- Complete the table.

Position in sequence	3	6	9	10	12	n
Term	-15	-12	-9		-6	

Patterns represented algebraically.

- Use the rule to complete each table.
  - Rule: $y = 3x - 1$

x	-2	-1	0	1	2	10	50
y							

These DBE workbook activities confirm that the ranges of patterns covered are the same as the ranges of patterns covered by the content standards. Nonetheless, other ranges of patterns covered by the DBE workbook which were labelled 'not applicable' level of agreement were beyond the scope of the content standards. The ranges of patterns were covered by the DBE workbook activities which were not covered on the content standards, and have been extracted from the mathematics Grade 9 DBE workbook.

Patterns with integers.

- Describe the pattern by giving the rule and then extend it with three more terms.
  - 1,-5, 2,-6, 3,-7

Patterns with common fractions.

- Describe the pattern by giving the rule and then extend it by three terms.
    - 729, 81, 9, 1, $\frac{1}{9}$, $\frac{1}{81}$

Patterns with decimal fractions.

- Describe the pattern by giving the rule and then extend it by three terms.
    - 25; 5; 1; 0,2; 0,04

These examples confirm that some ranges of patterns covered by the Grade 9 DBE workbook activities on NGP were beyond the scope of the content standards. However, other ranges of patterns to be covered in the mathematics Grade 9 are said to be those prescribed in Grade 8 under teaching guidelines, but in this case consolidation has to be done. This means that integration of different range of patterns can be done. Outlining the range of patterns under teaching guidelines create some gaps, since patterns involving decimal fractions and common fractions are outlined under teaching guidelines and not mentioned under the content standards. This is raised since this study focused on the ranges of patterns prescribed on the content standards. The level of agreement for the range of knowledge correspondence between the content standards and the mathematics Grade 9 DBE workbook activities on NGP is acceptable. Webb (1997) outlines that the range of knowledge correspondence is acceptable if nearly all the ranges of knowledge on the content standards are covered on the assessment activities.

❖ CALCULATION OF KRIPPENDORFF ALPHA

The inter-rater reliability was also measured for agreement and disagreement of the content analysts using Krippendorff alpha, as it is the most reliable alpha even though is difficult to calculate (Krippendorff, 2011). The Krippendorff alpha was employed on qualitative data since content analysts were coding independently. The researcher wanted to verify whether the data provided by the content analysts was reliable. Krippendorff alpha is able to measure observed and expected disagreement. Krippendorff alpha ranges from 0 to 1, where 1 indicates perfect reliability and 0 indicates absence of reliability. The Krippendorff alpha general form is as follows:

$$\alpha = 1 - \frac{D_0}{D_e}$$

where D_0 is the observed disagreement, D_e is the expected disagreement. The Krippendorff alpha simplest form is as follows:

$$\alpha = 1 - (n-1)\frac{O_{01}}{n_0 . n_1}$$

where n is the total number of responses, O_{01} is the total number of disagreement, $n0$ and $n1$ are the expected disagreements. The Krippendorff alpha was computed between SPMCS and DBE workbook activities on NGP for Grade 7, Grade 8 and Grade 9. The table below shows how Krippendorff alpha was computed.

Table 4. 28: The agreements and the disagreements of the content analysts

Criteria of content focus	**Grade**	**Total**	**Agreement**	**Disagreement**		
				Category 1	**Category 2**	**Category 3**
Categorical concurrence for Content standards	7	20	20			
	8	24	24			
	9	24	24			
Categorical concurrence for DBE workbook activities	7	108	106	2		
	8	48	47	1		
	9	28	28			
Depth of knowledge consistency for content standards	7	20	12	6	2	
	8	24	16	6	2	
	9	24	16	6	2	
Depth of knowledge consistency for DBE workbook activities9	7	108	88	3	8	9
	8	48	36	6	6	
	9	28	24	3	1	
Range of knowledge correspondence for content standards	7	20	20			
	8	24	24			
	9	24	24			
Range of knowledge correspondence for DBE workbook activities	7	108	102	6		
	8	48	48			
	9	28	28			
	Total	**756**	**687**	**39**	**21**	**9**

Table 4.28 above shows the agreements and disagreements for the content analysts during coding of the SPMCS and DBE workbook activities on NGP. The agreements and disagreements for the three criteria of content focus are outlined on this table, which are: categorical concurrence, DoK consistency and range of knowledge correspondence. Three categories of disagreements have been highlighted. The table was further summarised to enable the calculation of Krippendorff alpha. Table 4.29 below shows the summary of the agreements and disagreements of the content analysts.

Table 4. 29: Summary of the agreements and the disagreements of the content analysts

Total	756
Agreement	687
Disagreement	69
Expected disagreements on categorical concurrence for the content standards	68
Expected disagreements on categorical concurrence for the DBE workbook activities in NGP	184
Expected disagreements on DoK consistency for the content standards	68
Expected disagreements on DoK consistency for the DBE workbook activities in NGP	184
Expected disagreements on range of knowledge correspondence for the content standards	68
Expected disagreements on range of knowledge correspondence for the DBE workbook activities in NGP	184

Table 4.29 shows the summary of the agreements and the disagreements between the content analysts' coding. The expected disagreements for the criteria of content focus recommended by Webb (1997) have been highlighted as well. The computed Krippendorff alpha was found to be 0,999 that confirmed that the analysis made by the content analysts between SPMCS and DBE workbook activities was extremely reliable.

4.4. Synthesis of Findings

4.4.1. Alignment of Content Structure of Grade 7 Mathematics Content Standards and DBE Workbook Activities on NGP

The alignment of content structure of Grade 7 mathematics content standards and DBE workbook activities on NGP with the use of Webb's (1997) criteria of content focus were as follows: The level of agreement for the Grade 7 content standards and the DBE workbook activities on NGP was acceptable on the categorical concurrence and the range of knowledge correspondence. Under DoK consistency, the criterion was fully covered. The findings revealed that all the content prescribed on the mathematics content standards for the Grade 7 was fully covered by the DBE workbook activities on NGP. However, some of the content assessed on the DBE workbook activities were beyond the scope in terms of CAPS requirements. Similar findings were obtained by Tran (2016), on a study to examine the alignment between the CCSS for mathematics and the three U.S. high school textbooks series. The findings reveal that all CCSS for mathematics were covered, and additional learning expectations, not part of the CCSS, were found in the textbooks.

The implications of assessment on DBE workbook activities which is beyond the scope of content standards are that they may as well be taught in the classroom since they form part of the assessment activities on the worksheets. This could have a serious impact on time allocation to teach the topic. It must be clear that assessment is meant to measure content on the content standards. Hence, it is imperative for assessments to cover the expected content of the content standards (Porter, 2002). Aligning content standards with assessments have been proven to be capable of enhancing learner performance (Biggs, 2014; Shoveller et al., 2014).

Another matter of concern is that the DBE workbook activities on NGP as well as the corresponding content standards covered the cognitive levels:

‘knowledge’ and ‘routine procedures’. Cognitive levels on ‘complex procedures’ and ‘problem solving’ were not covered. On the other hand, CAPS recommend all the four cognitive levels in an assessment which are: ‘knowledge’, ‘routine procedures’, ‘complex procedures’ and ‘problem solving’. This creates a discrepancy in terms of the cognitive levels of the DBE workbook activities on NGP and content standards. However, CAPS recommend the four cognitive levels in a formal assessment task. Maybe the exclusion of ‘complex procedures’ and ‘problem solving’ was because the DBE workbook activities are more of a formative assessment than a formal assessment. However, all cognitive levels become imperative during formative assessment in order to practise for formal assessment.

Some of the DBE workbook activities for mathematics Grade 7 were classified as ‘problem solving’, but, according to the analysis, ‘problem solving’ was not identified. This creates discrepancy in classifying the cognitive levels of the assessment activities. It is important that assessment activities be classified correctly to avoid inappropriate classification. Webb (1997) as part of the theoretical framework guiding this study, emphasise that content standards should be cognitively aligned to the assessment. Thus, it is critical for content standards to be aligned to assessment, instruction, professional development and learning materials (Porter, 2002).

4.4.2. Alignment of Content Structure of Grade 8 Mathematics Content Standards and DBE Workbook Activities on NGP

The findings revealed that the alignment of Grade 8 content standards and DBE workbook activities in terms of the content structure are as follows: the level of agreement for the categorical concurrence and the range of knowledge correspondence were acceptable. Under the DoK consistency, the criterion was fully covered. The findings also revealed that the DBE workbook activities that required learners to describe the general rules of patterns were not clear on how learners were expected to describe. However, the content standards have put it categorically that general rules of patterns should be described in own words or in algebraic language. This is a matter that needs to be addressed when developing assessment activities, since assessment activities are developed to measure the content on the content standards.

The structuring of assessments should be in line with the content standards to yield better achievement and to improve the education system (Watermeyer, 2012). It is advisable for the assessment activities to have the same verbs used on the content standards to help in aligning the content standards and the assessment (Biggs, 2014). The DBE workbook activities only covered 'knowledge' and 'routine procedures' in terms of the cognitive level of the assessment activities, as in Grade 7. The cognitive levels on 'problem solving' and 'complex procedures' were not covered by the DBE workbook activities on NGP, even though some of the activities were labelled as 'problem solving', but not in the true sense of the cognitive levels. This could cause confusion for the teachers and learners in the classroom, since learners are expected to learn mathematics concepts from different cognitive levels as recommended by CAPS (DBE, 2011).

DBE (2011) further highlights that 'problem solving' questions might require a higher order understanding and an ability to break down the problem into its constituents parts. Hence, it is important to label the assessment activities correctly to avoid misguidance. Webb (1997) as the theoretical framework guiding this study highlights that what learners are expected to know or do on the assessment should be as demanding cognitively with the expectations from the content standards. Hence it is important to cognitively align content standards with the assessments.

4.4.3. Alignment of Content Structure of Grade 9 Mathematics Content Standards and DBE Workbook Activities on NGP

The findings revealed that the full level of agreement was obtained on the categorical concurrence and the DoK consistency criteria for Grade 9, while the range of knowledge correspondence was acceptable. This indicates that gaps exists between the content standards and the DBE workbook activities. The findings also show that the DBE workbook activities addressing description of general rule of patterns was not clear on how the patterns should be described. This is raised since the corresponding content standards expect learners to describe the general rules of patterns in own words or in algebraic language. The DBE workbook activities did not specify how the general rules should be described, but examples were provided to guide learners' responses.

This kind of question should be discouraged since questions are expected to be clear enough to guide learners' responses, unlike providing examples to bridge the gap. The provision of examples is a good guidance to learners, but questions should not be left incomplete hoping that the examples will close the gaps. This is raised to assist in enhancing the DBE workbook activities in future. The DBE workbooks are deliberately designed to supply teachers with worksheets for formative assessments and also prepare learners for their formal assessment, consequently summative assessment as well (DBE, 2013). Hence it is important to frame the DBE workbook activities well to prepare learners for formal tasks. In fact, assessment activities should be aligned to the content standards (Webb, 1997).

4.5. Extent of Alignment between the SPMCS and the DBE workbook Activities on NGP

4.5.1. Calculation of Alignment Indices

In the second stage of data analysis, quantitative data was generated to determine the alignment indices between the SPMCS and the DBE workbook activities on NGP. Porter's (2002) alignment model was employed in this study to calculate the alignment indices between SPMCS and DBE workbook activities on NGP. Porter recommends that two matrices for the content and the assessment be developed in order to compare cell-by-cell proportions. Proportions are fractions or percentages used to compare how much content or DBE workbook activities are covered by the cognitive levels. The content matrices covered the broad statements that outline the concepts and skills that learners should know for mathematics Grade 7, Grade 8 and Grade 9 (Addonizio & Kearney, 2012).

On the other hand, the assessment matrices covering the DBE workbook activities on NGP were also developed to facilitate the calculations of the alignment indices as recommended by Porter (2002). The matrices included content with cognitive levels, as well as assessment with the same cognitive levels. This was done since Porter's alignment model focuses on aligning content and assessment with the cognitive levels. The researcher adopted the 1999 TIMSS's cognitive levels to concur with CAPS as they are used in everyday teaching and assessment.

❖ EXTENT OF ALIGNMENT BETWEEN THE GRADE 7 MATHEMATICS CONTENT STANDARDS AND THE DBE WORKBOOK ACTIVITIES ON NGP

Grade 7 Porter's alignment index was calculated to explore the status of alignment between mathematics content standards and DBE workbook activities on NGP. Table 4.30 below shows the Grade 7 content matrix. Data was generated by the subject advisors serving as content analysts through mapping the content with the cognitive levels.

Table 4. 30: Grade 7 content matrix on NGP

Content on NGP	Cognitive levels			
	Knowledge	**Routine procedures**	**Complex procedures**	**Problem solving**
• Investigation and extension of numeric and geometric patterns.	$\frac{0,5}{2} = 0,25$	$\frac{0,5}{2} = 0,25$	0	0
• Description of the general rule of patterns in words.	$\frac{0,5}{2} = 0,25$	$\frac{0,5}{2} = 0,25$	0	0
Total cognitive score points	**1**	**1**	**0**	**0**
Total content proportions	**0,50**	**0,50**	**0,00**	**0,00**
Proportions % grand totals	**50,0%**	**50,0%**	**0,0%**	**0,0%**

Table 4.30 above is a content matrix which shows how Grade 7 mathematics content was mapped with the cognitive levels. Two content standards were identified (n=2) for mathematics Grade 7. The assessment matrix was also developed, where DBE workbook activities on NGP were mapped with the cognitive levels. This was done to compare the proportions between the content matrix and the assessment matrix. Table 4.31 below shows the Grade 7 assessment matrix on NGP.

Table 4. 31: Grade 7 assessment matrix on NGP

Content on NGP	Cognitive levels			
	Knowledge	**Routine procedures**	**Complex procedures**	**Problem solving**
• Investigation and extension of numeric and geometric patterns	$\frac{6}{27} = 0,22$	$\frac{7,5}{27} = 0,28$	$\frac{0}{27} = 0$	$\frac{0}{27} = 0$
• Description of the general rule of patterns in words	$\frac{4,5}{27} = 0,17$	$\frac{9}{27} = 0,33$	$\frac{0}{27} = 0$	$\frac{0}{27} = 0$
Total cognitive score points	**10,5**	**16,5**	**0,0**	**0,0**
Total assessment proportions	**0,39**	**0,61**	**0,00**	**0,00**
Proportions % grand totals	**39,0%**	**61,0%**	**0,0%**	**0,0%**

Table 4.31 above shows the Grade 7 assessment matrix on NGP which has been mapped with the cognitive levels. Twenty seven assessment activities were

identified ($n = 27$). The content proportions and the assessment proportions from both matrices were represented in a bar plot for readability. Figure 4.5 below shows the bar plot representing the content and assessment proportions for the mathematics Grade 7.

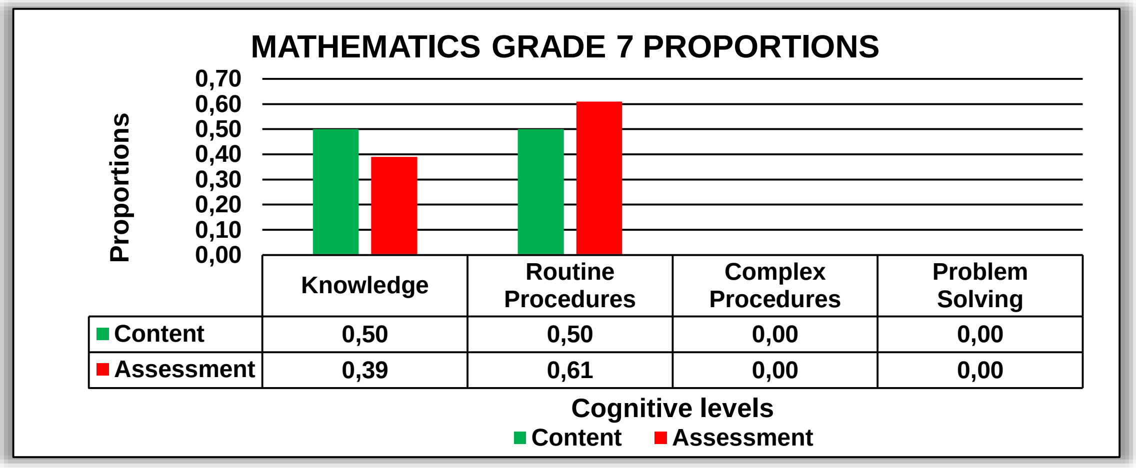


Figure 4. 5: Grade 7 content and assessment proportions

Figure 4.5 shows the graphical representation of the content and assessment proportions for the Grade 7. According to the findings, the mathematics Grade 7 content and the assessment proportions on 'knowledge' contributed 0,50 and 0,39 respectively. Proportions for the content and the assessment under 'routine procedures' contributed 0,50 and 0,61 respectively. Proportions for the mathematics Grade 7 content and the assessment under 'complex procedures' and 'problem solving' contributed 0,00. This is an indication that neither content nor assessment was covered on 'complex procedures' and 'problem solving'. This means that the content standards on NGP and the DBE workbook activities did not cover the cognitive levels on 'complex procedures' and 'problem solving'. However, CAPS recommend the four cognitive levels to be covered: 'knowledge', 'routine procedures', 'complex procedures' and 'problem solving'. This could have a negative impact on the cognition of the learners, since only low order assessment activities are covered. Besides, the mathematics Grade 7 content standards on NGP did not cover the 'complex procedures' and the 'problem solving', which could also reflect content of low order in the curriculum.

Subsequently, the proportions for both matrices were used to calculate Porter's alignment index. Calculations of Porter's alignment index between Grade 7 content and assessment proportions were done to give the degree of alignment. Porter's (2002) alignment model is measured by calculating cell-by-cell proportion intersections. Grade 7 had two content standards ($n = 2$) and 27 assessment activities ($n = 27$) to be compared. The Porter's alignment index used to calculate the alignment indices is as follows:

$$\text{Alignment index} = 1 - \frac{\sum |x - y|}{2}$$

where x and y represent proportions of the content and the assessment respectively. The sum of the difference of the absolute values of the cell-by-cell proportion intercepts was calculated and divided by two. Thereafter, the quotient was subtracted from one to give the value of the alignment indices. Porter uses a rating scale between 0 and 1, where 0 means no alignment and 1 means perfect alignment. The alignment indices give a clear picture on how well aligned are SPMCS and DBE workbook activities on NGP in terms of their depth of knowledge. The calculated sum of the absolute difference between the content matrix and assessment matrix for Grade 7 was 0,22. The sum was then divided by two to get 0,11. Finally the quotient was subtracted from one to give the value of the alignment index which is 0,89. The value of the alignment shows that the content standards for Grade 7 and the DBE workbook activities on NGP are significant at 89%. However, the discrepancy exists between the two components.

- EXTENT OF ALIGNMENT BETWEEN THE GRADE 8 MATHEMATICS CONTENT STANDARDS AND THE DBE WORKBOOK ACTIVITIES ON NGP

A comparison of proportions between the mathematics content and the assessment for mathematics Grade 8 was also conducted. Table 4.32 below shows the content matrix for mathematics Grade 8.

Table 4. 32: Grade 8 content matrix on NGP

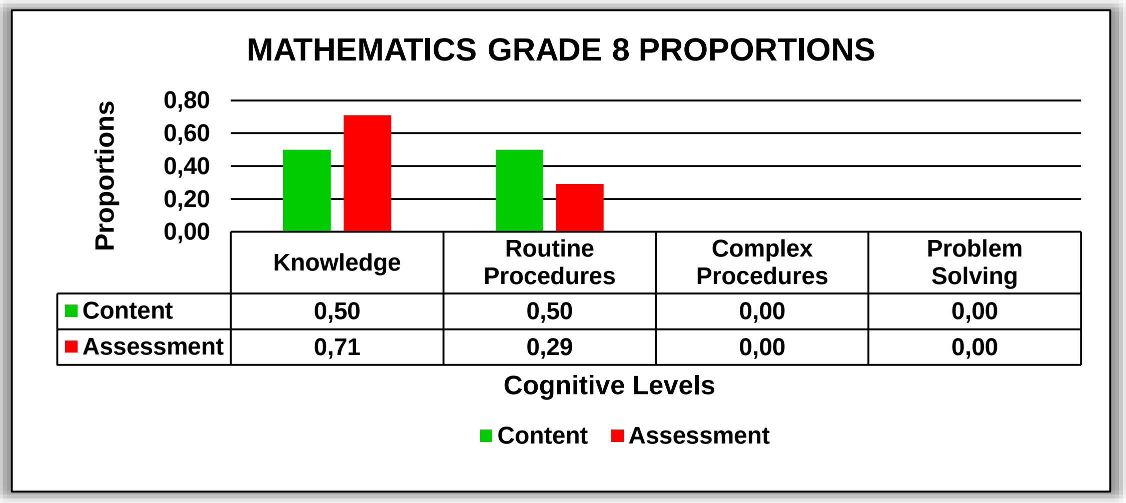
Content on NGP	**Cognitive levels**			
	Knowledge	**Routine procedures**	**Complex procedures**	**Problem solving**
• Investigation and extension of numeric and geometric patterns.	$\frac{0,5}{2} = 0,25$	$\frac{0,5}{2} = 0,25$	$\frac{0}{2} = 0$	$\frac{0}{2} = 0$
• Description of the general rule of patterns in words or in algebraic language.	$\frac{0,5}{2} = 0,25$	$\frac{0,5}{2} = 0,25$	$\frac{0}{2} = 0$	$\frac{0}{2} = 0$
Total cognitive score points	**1**	**1**	**0**	**0**
Total content proportions	**0,50**	**0,50**	**0,00**	**0,00**
Proportions % grand totals	**50,0%**	**50,0%**	**0,0%**	**0,0%**

Table 4.32 shows Grade 8 content matrix on NGP which has been mapped with the cognitive levels. Again, the assessment matrix for the mathematics Grade 8 was done to be able to calculate the Porter’s alignment index by comparing cell-by-cell intercepts with the content matrix proportions and the assessment matrix proportions as recommended by Porter. Table 4.33 below is an assessment matrix for Grade 8, mapped with the cognitive levels.

Table 4. 33: Grade 8 assessment matrix on NGP

Content on NGP	Cognitive levels			
	Knowledge	Routine procedures	Complex procedures	Problem solving
• Investigation and extension of numeric and geometric patterns.	$\frac{7,75}{12} = 0,65$	$\frac{2,75}{12} = 0,23$	$\frac{0}{12} = 0$	$\frac{0}{12} = 0$
• Description of the general rule of patterns in words or in algebraic language.	$\frac{0,75}{12} = 0,06$	$\frac{0,75}{12} = 0,06$	$\frac{0}{12} = 0$	$\frac{0}{12} = 0$
Total cognitive score points	**8,5**	**3,5**	**0**	**0**
Total content proportions	**0,71**	**0,29**	**0,00**	**0,00**
Proportions % grand totals	**70,8%**	**29,2%**	**0,0%**	**0,0%**

Table 4.33 above shows the proportions covered by mathematics Grade 8 assessment which focused on the DBE workbook activities on NGP. The proportions from both content matrix and assessment matrix were represented in a bar plot for readability. Figure 4.6 below is a representation of mathematics Grade 8 content and assessment proportions.



	Knowledge	Routine Procedures	Complex Procedures	Problem Solving
Content	0,50	0,50	0,00	0,00
Assessment	0,71	0,29	0,00	0,00

Figure 4. 6: Grade 8 content and assessment proportions

Figure 4.6 above shows the proportions identified from the content matrix and the assessment matrix. The analysis revealed that proportions for Grade 8 mathematics content standards and DBE workbook activities on cognitive level ‘knowledge’ contributed 0,50 and 0,71 respectively. On ‘routine procedures’, content standards contributed 0,50, while DBE workbook activities contributed 0,29. Nevertheless, ‘complex procedures’ and ‘problem solving’ contributed 0,00 in both the content standards and the DBE workbook activities. This shows that the cognitive levels: ‘complex procedures’ and ‘problem solving’, were not covered on both content standards and assessment activities. This indicates that the content standards for mathematics Grade 8 on NGP did not cover these cognitive levels. The same applies to the DBE workbook activities on NGP. However, CAPS recommend the four cognitive levels adopted from TIMSS which are ‘knowledge’, ‘routine procedures, ‘complex procedures’ and ‘problem solving’.

Calculation of Porter’s alignment index was also done in mathematics Grade 8 to determine the degree of alignment in terms of the alignment index. The number of content standards for mathematics Grade 8 was two ($n = 2$) and the number of DBE workbook activities was twelve ($n = 12$). The proportions for cell-by-cell were used to calculate the alignment indices. The calculated sum of the absolute difference between the content matrix and assessment matrix for Grade 8 was 0,79. The sum was then divided by two to get 0,40. Finally the quotient was subtracted from one to give the value of the alignment index which is 0, 60. Hence, the computed Porter’s alignment index between the mathematics Grade 8 and the DBE workbook activities on NGP was 0,60, which amount to 60%. The following is the exploration of the mathematics Grade 9 Porter’s alignment index.

- ❖ EXTENT OF ALIGNMENT BETWEEN THE GRADE 9 MATHEMATICS CONTENT STANDARDS AND THE DBE WORKBOOK ACTIVITIES ON NGP

The comparison of content and assessment proportions with the cognitive levels was also conducted in the mathematics Grade 9. The alignment study focused on all the grades in the senior phase, in order to give the alignment status between SPMCS and DBE workbook activities on NGP for the whole phase. Table 4.34 below shows the content matrix for the mathematics Grade 9.

Table 4. 34: Grade 9 content matrix on NGP

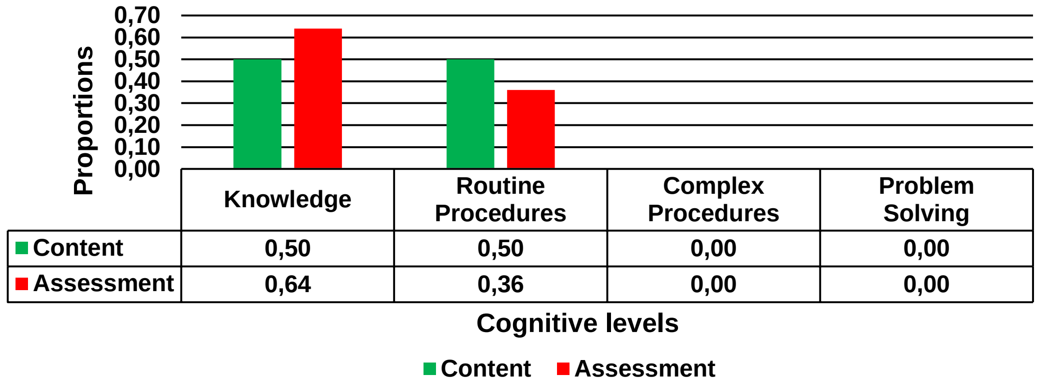
Content on NGP	Cognitive levels			
	Knowledge	Routine procedures	Complex procedures	Problem solving
• Investigation and extension of numeric and geometric patterns.	$\frac{0,5}{2} = 0,25$	$\frac{0,5}{2} = 0,25$	$\frac{0}{2} = 0$	$\frac{0}{2} = 0$
• Description of the general rule of patterns in words or in algebraic language.	$\frac{0,5}{2} = 0,25$	$\frac{0,5}{2} = 0,25$	$\frac{0}{2} = 0$	$\frac{0}{2} = 0$
Total cognitive score points	**1**	**1**	**0**	**0**
Total content proportions	**0,50**	**0,50**	**0,00**	**0,00**
Proportions % grand totals	**50,0%**	**50,0%**	**0,0%**	**0,0%**

Table 4.34 above shows the proportions of content according to the cognitive levels. The content matrix was used together with the assessment matrix, to calculate the Porter's alignment index. Table 4.35 below shows the assessment matrix for the Grade 9.

Table 4. 35: Grade 9 assessment matrix on NGP

Content on NGP	Cognitive levels			
	Knowledge	Routine procedures	Complex procedures	Problem solving
• Investigation and extension of numeric and geometric patterns.	$\frac{3,75}{7} = 0,54$	$\frac{1,75}{7} = 0,25$	$\frac{0}{7} = 0$	$\frac{0}{7} = 0$
• Description of the general rule of patterns in words or in algebraic language.	$\frac{0,75}{7} = 0,11$	$\frac{0,75}{7} = 0,11$	$\frac{0}{7} = 0$	$\frac{0}{7} = 0$
Total cognitive score points	**4,5**	**2,5**	**0**	**0**
Total content proportions	**0,64**	**0,36**	**0,00**	**0,00**
Proportions % grand totals	**64,3%**	**35,7%**	**0,0%**	**0,0%**

Table 4.35 above shows the assessment proportions according to the cognitive levels. The two matrices for the content and the assessment were used to calculate the Porter's alignment index. The graphical representation for the proportions was also done for readability. Figure 4.7 below shows the bar plot representing Grade 9 proportions in terms of the content and the assessment.



	Knowledge	Routine Procedures	Complex Procedures	Problem Solving
Content	0,50	0,50	0,00	0,00
Assessment	0,64	0,36	0,00	0,00

Figure 4. 7: Grade 9 content and assessment proportions

Figure 4.7 above is the graphical representation of the content proportions and assessment proportions for the mathematics Grade 9. The findings highlight that the proportions for the content and the assessment under ‘knowledge’ contributed 0,50 and 0,64 respectively. The proportions for the content and the assessment under cognitive level ‘routine procedures’ contributed 0,50 and 0,36 respectively. There were no content and assessment covered under ‘complex procedures’ and ‘problem solving’. This shows that the content standards and the DBE workbook activities on NGP did not cover the cognitive levels: ‘complex procedures’ and ‘problem solving’.

The alignment index between mathematics Grade 9 content and assessment was calculated to give the degree of alignment. The content standards were two ($n = 2$), while assessment activities had seven items ($n = 7$). The calculated sum of the absolute difference between the content matrix and the assessment matrix for Grade 9 was 0,57. The sum was then divided by two to get 0,29. Finally the quotient was subtracted from one to give the value of the alignment index which is 0,71, which amount to 71%.

❖ CALCULATED ALIGNMENT INDICES FOR GRADE 7, GRADE 8 AND GRADE 9

The calculated Porter's alignment indices for Grade 7, Grade 8 and Grade 9 were: 0, 89; 0,60 and 0,71 respectively. In percentage, the alignment indices for Grade 7, Grade 8 and Grade 9 were found to be 89%, 60% and 71% respectively. The analysis shows that the alignment indices between the SPMCS and the DBE workbook activities on NGP were above 0,5 (50%) which shows acceptable alignment. According to Porter (2002), 0 means no alignment and 1 means perfect alignment. So the alignment indices between the SPMCS and the DBE workbook activities range from 0,60 (60%) to 0,89 (89%). The following Figure 4.8 shows the graphical representation of the calculated alignment indices for the Grade 7, Grade 8 and Grade 9.

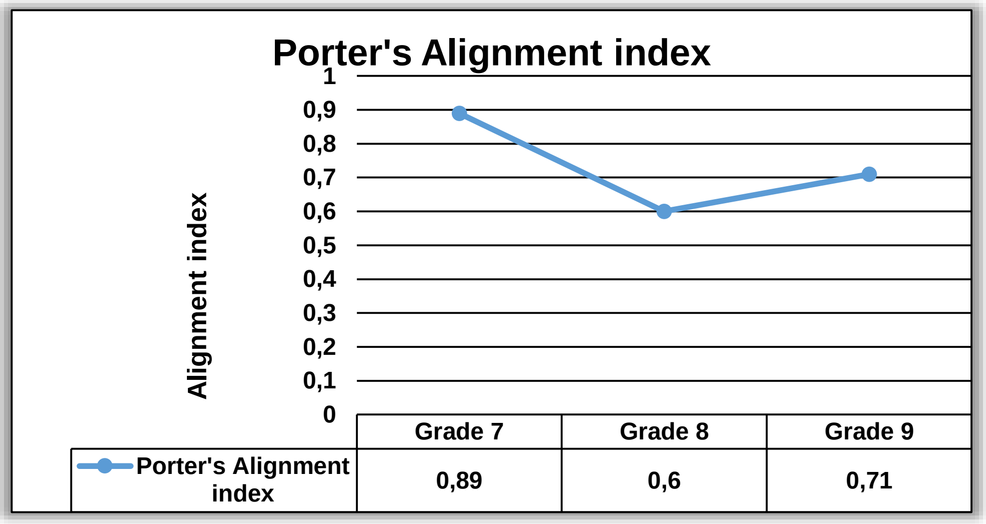


Figure 4. 8: Grades 7 to 9 alignment indices

Figure 4.8 gives the overall Porter's (2002) computed alignment indices for the three grades in the senior phase, in terms of how well aligned is the SPMCS and the DBE workbook activities on NGP. The analysis shows that the SPMCS and DBE workbook activities are significantly aligned. Their alignment indices range from 60% to 89% which shows significant alignment. The graph shows that the Grade 7 has a higher alignment index than the Grade 8 and the Grade 9. The calculated alignment indices between SPMCS and DBE workbook activities were: 0,89; 0,60 and 0,71 for Grade 7, Grade 8 and Grade 9 respectively. In terms of percentages, 89%, 60% and 71% were obtained in the Grade 7, Grade 8 and Grade 9 respectively.

❖ DISCREPANCIES OBSERVED IN GRADE 7, GRADE 8 AND GRADE 9

The alignment indices shows significant alignment, but the percentage deficit is a cause for concern that needs to be addressed. The percentage deficit shows that the discrepancies exists between SPMCS and DBE workbook activities on NGP. In Figure 4.9 below the discrepancies between SPMCS and DBE workbook activities on NGP are displayed.

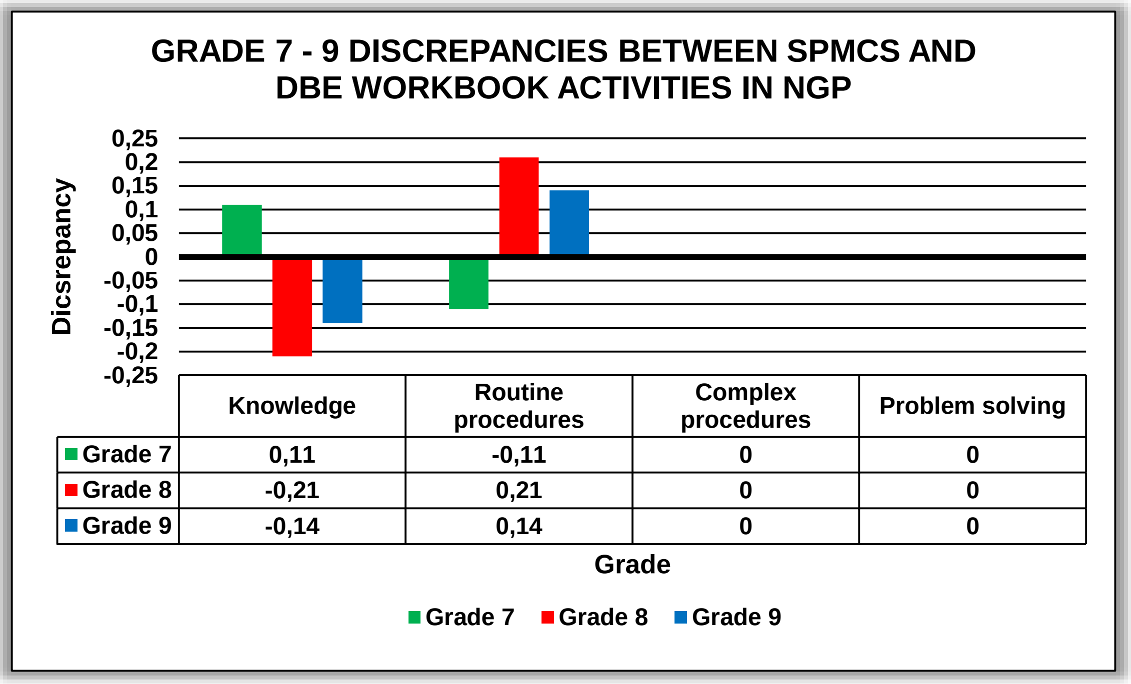


Figure 4. 9: Grades 7 to 9 discrepancies between SPMCS and DBE workbook activities

Figure 4.9 shows the discrepancies obtained between the SPMCS and the DBE workbook activities on NGP. A discrepancy can either be weak, strong or no discrepancy at all. A weak discrepancy is represented by bars pointing downwards, a strong discrepancy is represented by bars pointing upwards, while no discrepancy is represented by a line lying on the zero (Ndlovu & Mji, 2012). According to the findings, weak, strong and zero discrepancies between SPMCS and DBE workbook activities on NGP were discovered. Under ‘knowledge’, Grade 7 and Grade 8 showed a weak discrepancy when it comes to aligning the content standards and the DBE workbook activities on NGP, while Grade 7 showed a strong discrepancy.

Again under ‘routine procedures’ the Grade 7 showed a weak discrepancy while the Grade 8 and the Grade 9 showed strong discrepancy. However, ‘complex procedures’ and ‘problem solving’ were found to be lying on the zero which shows that no discrepancy was observed. When conducting alignment study, it is very critical to highlight the degree of alignment as well as the discrepancies, so as to minimise discrepancies when reviewing curriculum and developing the learning materials and the assessments in future.

4.6. Synthesis of findings

4.6.1. Extent of Alignment between the Grade 7 Mathematics content Standards and the DBE workbook Activities on NGP

The calculated Porter’s alignment index between the Grade 7 content standards and the DBE workbook activities on NGP revealed that the two components were significantly aligned. The calculated Porter’s alignment index for the Grade 7 was 0,89. The findings confirm that the mathematics Grade 7 content standards and the DBE workbook activities on NGP are significantly aligned. This confirms the caption outlined on the DBE workbooks cover page which says ‘CAPS aligned’. This indicates that the Grade 7 DBE workbooks have been developed in line with the content standards prescribed for the Grade 7 on NGP. However, discrepancies were also identified, with a weak and strong discrepancy of 0,11 and -0,11 on ‘knowledge’ and ‘routine procedures’ respectively. Again no discrepancy was seen on ‘complex procedures’ and ‘problem solving’. The findings revealed a strong discrepancy under ‘knowledge’ questions, weak discrepancy under ‘routine procedures’ and no discrepancy under ‘complex procedures’ and ‘problem solving’ questions.

4.6.2. Extent of Alignment between the Grade 8 Mathematics content Standards and the DBE workbook Activities on NGP

The calculated Porter’s alignment index between the mathematics Grade 8 content standards and the DBE workbook activities on NGP revealed that the two components were aligned. The calculated Porter’s alignment index between the mathematics Grade 8 content standards and the DBE workbook activities on NGP in terms of cognitive levels was 0,60. The alignment index shows that the alignment is moderate. This indicates that the alignment is significantly good, since 0 means no alignment and 1 means perfect alignment (Porter, 2002).

Besides good alignment, weak and strong discrepancies were also identified, where ‘knowledge’ had a weak discrepancy, ‘routine procedures’ had strong discrepancy, and ‘complex procedures’ and ‘problem solving’ had no discrepancy at all. It is also important to highlight that no ‘complex procedures’ and ‘problem solving’ assessment activities were identified from the mathematics Grade 8 DBE workbook activities on NGP. It is good that both the content standards and the DBE workbook activities did not cover ‘complex procedures and ‘problem solving’, since both components have to be aligned. However, CAPS recommend all the four cognitive levels in a formal assessment task, which shows that all the four cognitive levels are significant. The implications of using workbooks could be that learners may be subjected to assessment activities that are pitched at ‘knowledge’ and ‘routine procedures’ only, which means, when engaged to formal assessments, they may experience challenges when assessment activities are pitched at ‘complex procedures’ and ‘problem solving’ level.

The researcher partly supports the recommendation made by Hoadley and Galant (2016) that workbooks could be used for practice, assessment, monitoring and teaching. From the findings, the researcher sees workbooks as practice tools for the mastery of concepts and not for teaching and assessment, since ‘complex procedures’ and ‘problem solving’ are not covered

4.6.3. Extent of Alignment between the Grade 9 Mathematics content Standards and the DBE workbook Activities on NGP

The Porter’s alignment index calculated between the Grade 9 content standards and the DBE workbook activities in terms of cognitive levels was 0,71. This shows good alignment between the two components since it is at 71%. Discrepancies were also identified between the mathematics Grade 9 content standards and the DBE workbook activities on NGP. Both weak and strong discrepancies were identified. Weak discrepancies contributed -0,14 while strong discrepancies contributed 0,14. No discrepancies were identified under ‘complex procedures’ and ‘problem solving’.

4.7. Conclusion

The purpose of this study was to explore the alignment between senior phase mathematics content standards and numeric and geometric patterns’ workbook activities. The findings revealed that SPMCS and DBE workbook activities on NGP have good alignment in terms of content structure and alignment indices. The content standards and the DBE workbook activities acceptably covered the criterion under categorical concurrence for Grade 7 and Grade 8, while Grade 9 fully covered the criterion. In contrast, some of the content assessed in Grade 7 and Grade 8 was beyond the scope of the content standards. This creates a discrepancy between the two components. Under DoK consistency, Grade 7, Grade 8 and Grade 9 fully covered the criterion. Under range of knowledge correspondence, Grade 7, Grade 8 and Grade 9 acceptably covered the criterion.

The calculated Porter’s alignment indices for the Grade 7, Grade 8 and Grade 9 were: 0,89; 0,60 and 0,71 respectively. Moreover, weak and strong discrepancies were obtained between the SPMCS and the DBE workbook activities on NGP. This needs to be taken into consideration when developing DBE workbooks in future.

Again the ‘complex procedures’ and ‘problem solving’ were not covered on both SPMCS and DBE workbook activities on NGP. These cognitive levels need to be considered to cater for different cognitive levels in teaching, learning and assessment. The curriculum developers should categorically structure content in a manner that guides the developers of learning materials and assessments on expected assessment activities. For example, content should indicate that term number/ term value/ positions of the term should be calculated, so as to guide the developers of assessments correctly on questions that require term numbers and term values to be calculated.

General statements on policy document should be avoided at all costs. If all the aspects raised could be addressed, then learning materials would be likely to improve. Also, teaching guidelines should have same content with the content standards. The mismatch was observed when clarifying description of pattern in own words, the teaching guidelines made mention of the description of patterns in algebraic language, while the Grade 7 content standards are silent about the algebraic language. Above all, developers of learning materials should be aware that it is imperative to align assessments and learning materials with the content standards to enhance the quality of the education system.

In triangulating the two alignment models, the findings revealed that SPMCS and DBE workbook activities have good alignment status. In all the models, ‘complex procedures’ and ‘problem solving’ were not identified from both content standards and DBE workbook activities on NGP for the Grade 7, Grade 8 and Grade 9. However, Webb (1997) produced acceptable alignments in terms of the cognitive level between SPMCS and DBE workbook activities on NGP. On the other hand, Porter (2002) also produced significant alignment indices between SPMCS and DBE workbook activities on NGP. However, a gap was identified on Webb's alignment model, where the scale of agreement on categorical concurrence and the range of knowledge correspondence did not cater for a situation where assessment activities measured content which is beyond the scope of the content standards. The two alignment models emphasise that the educational components have to be cognitively aligned, and all the models managed to highlight the status of alignment in terms of the cognitive levels.

However, other dimensions that Webb identified such as the content covered and the ranges of patterns covered, Porter could not highlight. Again, the alignment indices that Porter observed, could not be emphasised by Webb. Furthermore, Webb managed to highlight the kind of discrepancies that exists between the SPMCS and the DBE workbook activities on NGP, while Porter only noted the values of discrepancies in terms of the cognitive levels. Hence employing the two alignment models helped a great deal in exposing the degree of alignment comprehensively. The researcher recommends that the two alignment models for exploring alignment between the educational components to complement one another and for the comprehensive results.

In triangulating the qualitative data and qualitative data, both data highlighted that the status of alignment is significantly good. Nevertheless, the qualitative data recorded the status of alignment in terms of how the content has been structured between SPMCS and DBE workbook activities. The findings may help to enhance the content structure of the DBE workbook as well as the content in the CAPS document, since similarities and discrepancies have been highlighted. Despite that, the quantitative data managed to highlight the discrepancies and the similarities in terms of the alignment indices, which qualitative data could not highlight. Hence, the two set of data assisted in answering the research questions and effectively produce comprehensive results. Therefore this study managed to answer the main research question: 'To what extent are the senior phase mathematics content standards aligned with the Department of Basic Education workbook activities on numeric and geometric patterns?’.

5. CHAPTER FIVE
SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1. Introduction

This study sought to explore the degree of alignment between SPMCS and DBE workbook activities on NGP. This study was prompted by the fact that some teachers use DBE workbooks interchangeably with the textbooks for teaching and learning, while DBE workbooks are developed primarily to supplement teaching and learning resources. The literature indicated that the status of alignment on senior phase mathematics DBE workbooks was not confirmed through alignment studies. Hence, this study sought to explore the alignment between SPMCS and DBE workbook activities on NGP. This study may contribute towards enhancing the development of assessments and learning materials in future. This is anticipated since this study managed to expose the status of alignment in terms of the content structure and the alignment indices.

5.2. Research Design and Method

The methodology adopted for this study was mixed methods research, where qualitative data and quantitative data were triangulated to enhance comprehensive results (Ngulube & Ngulube, 2015). The research design employed was the exploratory sequential design. The exploratory sequential design had two parts and two phases. The exploratory sequential design is outlined below: Under part one of phase one, qualitative data was generated through mapping SPMCS and DBE workbook activities on NGP according to Webb's (1997) criteria of content focus. This was done to explore the content structure in terms of categorical concurrence, DoK consistency and range of knowledge correspondence. Subject advisors who served as content analysts coded the qualitative data individually. Coding focused on mapping the content standards and the DBE workbook activities with the cognitive levels, relevant content covered and range of patterns covered.

The instruments to explore categorical concurrence were developed to verify whether SPMCS and DBE workbook activities on NGP were aligned in terms of content. Again, Instruments to explore DoK consistency were developed to verify if cognitive levels of the DBE workbook activities on NGP are well aligned with the SPMCS. The content analysts also used separate instruments to explore the range of knowledge correspondence, where the breadth of knowledge in terms of the range of patterns covered by both SPMCS and DBE workbook activities were verified.

In part one of phase two, the quantitative data was generated by verifying the highest commonality of content between the content analysts' coding. Again, Krippendorff alpha was calculated to verify the reliability of the data from the content analysts. This was done to explore the criteria of content focus which are: categorical concurrence, DoK consistency and range of knowledge correspondence. Part two of phase one was used to generate quantitative data by categorising SPMCS and DBE workbook activities on NGP matrices according to their cognitive levels to explore alignment indices.

Lastly, part two of phase two was used to generate descriptive statistical data where cognitive score points, total content proportions, proportions grand total, alignment indices and discrepancies were explored to examine the status of alignment. The phases and the sequence of the research design contributed in guiding this study in the right direction, as well as producing the comprehensive results.

5.3. Summary and Interpretation of the Research Findings

The alignment between content standards and assessment could be examined through the use of criteria of content focus as recommended by Webb (1997). This led the exploration into one main research question and two sub-questions.

The two sub-questions were developed to assist in answering the main research question which was: To what extent are the senior phase mathematics content standards aligned with the Department of Basic Education workbook activities on numeric and geometric patterns?.

5.3.1. Research Question One

The first sub-question was: What content structure do the senior phase mathematics and Department of Basic Education workbook activities on numeric and geometric patterns have? In answering this research question, Webb's (1997) three criteria of content focus were employed to categorise SPMCS and DBE workbook activities on NGP, with the aim of analysing the content structure. Document analysis was conducted on SPMCS and DBE workbook activities on NGP by the content analysts. The following areas were explored: consistency of content, range of patterns and the cognitive levels of the content. Table 5.1 below shows the summary of the research findings.

Table 5. 1: Summary of research findings

Grade	Status of Alignment		
	Webb (1997)		Porter (2002)
	Criteria of content focus	**Level of agreement**	**Alignment indices**
Grade 7	Categorical concurrence	Acceptable	0,89
	Depth of knowledge consistency	Full	
	Range of knowledge correspondence	Acceptable	
Grade 8	Categorical concurrence	Acceptable	0,60
	Depth of knowledge consistency	Full	
	Range of knowledge correspondence	Acceptable	
Grade 9	Categorical concurrence	Full	0,71
	Depth of knowledge consistency	Full	
	Range of knowledge correspondence	Acceptable	

Table 5.1 above illustrate the summary of the research findings. Under categorical concurrence, the findings showed that Grade 7 and Grade 8 had acceptable level of agreement, while Grade 9 had full level of agreement. Under DoK consistency, Grade 7, Grade 8 and Grade 9 had full level of agreement. Under range of knowledge correspondence, Grade 7, Grade 8 and Grade 9 had acceptable level of agreement.

The content standards and the DBE workbook activities had good alignment, where the Webb's (1997) criteria of content focus were ranging from 'acceptable' level of agreement to 'full' level of agreement. This indicates that the content standards had good alignment with the DBE workbook activities on NGP. However, elements of misalignment were also identified. These findings could be the way they are since DBE workbooks are designed to supplement textbooks and provide worksheets for the learners (DBE, 2013). These show how the content structure of the SPMCS and DBE workbook activities on NGP have been done. It is imperative to record how content of the DBE workbook activities has been structured in relation to the content standards. This may help improve the structure of the DBE workbook activities in future.

5.3.2. Research Question Two

The second research sub-question focused on alignment indices between SPMCS and DBE workbook activities on NGP. The research question was: 'How do the senior phase mathematics content standards align with the Department of Basic Education workbook activities on the numeric and geometric patterns content standards?'. Porter (2002) was employed to calculate the alignment indices between SPMCS and DBE workbook activities on NGP. Three content matrices and three assessment matrices for the three grades in the senior phase were developed to help calculate alignment indices by comparing their proportions. Porter's alignment index was used to calculate the alignment indices.

Table 5.1 above also shows the calculated alignment indices for Grade 7, Grade 8 and Grade 9 which range from moderate to strong alignment at 0,89; 0,60 and 0,71 respectively. These alignment indices indicate that the DBE workbooks were developed in line with the SPMCS, even though not fully, since there is a deficit on the alignment indices. However, the findings revealed that the assessment activities on the DBE workbooks for Grade 7, Grade 8 and Grade 9 were developed following the SPMCS. Discrepancies were also identified. Moreover, the calculated Krippendorff alpha was found to be 0,999. This indicates that the data collected by the content analysts were reliable. Krippendorf alpha was employed to measure the congruity of agreements and disagreements of the content analysts (Krippendorff, 2011). Krippendorff alpha ranges from 0 to 1, where 1 indicates perfect reliability and 0 indicates absence of reliability. According to the findings, 0, 9999 is closer to 1, which confirms that the data collected by the content analysts were reliable. The alignment indices show that DBE workbook activities on NGP are aligned to the SPMCS, but with some discrepancies.

Two alignment models managed to answer the research questions effectively. The first alignment model, Webb (1997), managed to highlight the content structure between the SPMCS and DBE workbook activities on NGP. The findings revealed that the SPMCS and DBE workbook activities on NGP are well structured in terms of the categorical concurrence, the depth of knowledge consistency and the range of knowledge correspondence. This alignment model highlighted the content covered in both SPMCS and DBE workbook activities, as well as the content covered by the assessment activities that is beyond the scope of the content standards.

The Webb's alignment model also highlighted the ranges of patterns covered by both SPMCS and DBE workbook activities, as well as the range of patterns covered by the assessment activities, which are beyond the scope of the SPMCS. These findings were obtained on Webb's (1997) alignment model and not exposed on Porter's alignment model. However, the two alignment models managed to highlight the cognitive levels covered by both SPMCS and DBE workbook activities. Moreover, Porter's alignment model also managed to expose the alignment indices which were not highlighted on Webb's alignment model. So the two alignment models complemented each other in achieving the goal of this study. What Webb could not highlight, it was well highlighted by Porter and vice versa.

5.4. Recommendations

The two alignment models employed in this study exposed the alignment status of the SPMCS and DBE workbook activities on NGP in terms of the content structure and alignment indices. Webb's (1997) criteria of content focus categorically outlined how the content standards and the DBE workbook activities were structured in terms of content. This includes the consistency of the content, the ranges of patterns covered and the cognitive level of the content. Webb alignment model managed to show exactly where the discrepancies exists. Porter's (2002) alignment model managed to reveal the alignment status in terms of the alignment indices. In comparing the two alignment models, this study found that the two alignment models highlighted different critical areas. What the other alignment model managed to expose, it was not exposed by the other or rather recorded in details. Therefore, this study recommends the two alignment models to comprehensively explore the alignment status of the educational components. Hence, the two alignment models were more valuable than a singular alignment model.

Studies such as this should be conducted to ascertain quality in the development of the learning materials and the assessments in future. Content standards should be clear in order to minimise misalignment and guide instruction, development of learning materials and assessment. Concepts and skills to be achieved on the content standards should be clearly outlined, not equivocal, and general statements should be avoided at all costs. Teaching guidelines should have the same content with the content standards. The mismatch was observed on the teaching guidelines where description of patterns in own words was mentioned in Grade 7. The teaching guidelines made mention of algebraic language on description of patterns, when the content standards in Grade 7 were silent about describing patterns in algebraic language.

Furthermore, all ranges of patterns to be covered should be outlined on the content standards, rather than mentioning them on the teaching guidelines only. This is recommended as a guideline to the developers of assessments, learning materials and teachers in the classroom. Above all, the developers of learning materials should be aware that it is imperative to align assessments and learning materials with content standards. Before assessment activities could be developed, it is important to assess the cognitive level of the content standards, this will give guidance on what cognitive level the assessment activities must be pitched. Webb (1997) recommend that content standards be cognitively aligned to the assessment.

Another area to be recommended is on the scale of agreement for Webb's (1997) criteria of content focus under categorical concurrence and range of knowledge correspondence. The scale of agreement should also cater for a situation where assessment has covered content that is beyond the scope of the content standards. This may widen the scope of exploring alignment between content standards and assessment.

Lastly, only two cognitive levels were covered by the DBE workbook activities and the SPMCS, while CAPS recommend four. The cognitive levels on 'complex procedures' and 'problem solving' were not covered by both SPMCS and DBE workbook activities on NGP, only 'knowledge' and 'routine procedures' were covered. It is recommended that all four cognitive levels be covered on both SPMCS and DBE workbook activities on NGP. If all the aspects raised could be addressed, learning materials and assessment would be likely to improve.

5.5. Contributions of the Study

This study may contribute to the body of knowledge to assist future researchers, since few alignment studies have been reported in South Africa. Developers of assessments and learning materials may as well benefit, since guidelines on aligning educational components with content standards have been highlighted. In addition, the status of alignment in terms of the content structure and the alignment indices between the SPMCS and the DBE workbook activities on NGP have been confirmed through this alignment study. This specific area of study has not previously been investigated, and this might make a positive contribution to the DBE in terms of enhancing the quality of the DBE workbook activities on NGP.

Another contribution anticipated is skills development in the area of developing assessments and learning materials that are aligned to content standards. One more contribution is that in using both alignment models: Webb (1997) and Porter (2002), they complemented one another and exposed the status of alignment in terms of the content structure and the alignment indices. This study may help teachers to realise the importance of aligning content standards with instruction, assessment and learning materials. Curriculum developers and policy makers may be in a position to see the similarities and the discrepancies found in this study, to help strengthen the curriculum framework in future. Teachers may be in the position to spot the qualitative assessments and learning materials in future.

Above all, this study has contributed to the body of knowledge in terms of extending the scale of agreement recommended by Webb (1997) on categorical concurrence and the range of knowledge correspondence to cater for content on assessment that is beyond the scope of the content standards. The researcher recommends that 'not applicable' can be used to cater for content on assessment that is beyond the scope of the content standards. This calls for further studies on the theoretical framework to cater for inclusive dimensions on the scale of agreement for the categorical concurrence and the range of knowledge correspondence, even on the other criteria of content focus recommended by Webb (1997).

5.6. Limitations of the Study

This study focused on exploring the alignment between SPMCS and DBE workbook activities on NGP. This study focused on just one content area and one topic on SPMCS, which qualifies the sample to be small. Moreover, the findings of this study highlighted the status of alignment between SPMCS and DBE workbook activities on NGP rather than the entire workbooks. However the topic was extensively explored and highlighted the status of alignment between SPMCS and DBE workbook activities on NGP and also shed light onto issues of enhancing alignment between content standards, assessment and learning materials. However, the scope of the research best suits the level at which this study was conducted.

A study conducted by Hoadley and Galant (2016) on alignment between content standards and DBE workbooks in Grade 3 for literacy and numeracy confirmed that alignment is moderate to strong positive alignment. The findings of this study are similar to the findings presented by Hoadley and Galant (2016). This adds credibility to this study. Therefore the findings of this study serve as a base for future researches on extended scope.

5.7. Experience Gained from this Study

The researcher can confirm that she learnt a lot from this alignment study. What can be exposed to future researchers is that working with two alignment models was a good experience and produced comprehensive results. This is supported by Newton and Kasten (2013) who found that coupling two alignment models provide different perspectives on the alignment of content standards and assessment. The first alignment model explored was Webb (1997). This alignment model focused on criteria of content focus, which exposed the status of alignment in terms of the content structure between SPMCS and DBE workbook activities on NGP. It gave a clear indication of where issues of alignment and misalignment exist. The Webb's alignment model exposed even the kind of content assessed which was beyond the scope of the content standards. As a result, the alignment in terms of the content structure was highlighted comprehensively.

Again, Porter (2002) was employed to explore the alignment in terms of the alignment indices. Applying the two alignment models exposed different dimensions in terms of the status of alignment between SPMCS and DBE workbook activities on NGP. What the one alignment model could do, the other could not highlight. Webb's alignment model exposed alignment in terms of how the content has been structured and also highlighted the discrepancies in details. On the other hand, what Porter managed to expose, Webb could not expose. Porter exposed the alignment status in terms of the values of the alignment indices and discrepancies. However, Porter's alignment model did not specify in detail the kind of discrepancies obtained in terms of the content structure and only highlighted statistical values. Hence, triangulation was brought in to close the gap on what the other model could not achieve.

Another area that was learnt from this study is that alignment between content standards and assessment is critical, and should be considered in all educational components. The researcher learnt about alignment in educational components and the benefits thereof.

5.8. Concluding Remarks

This study was conducted to explore the alignment between SPMCS and DBE workbook activities on NGP. This study succeeded in exposing the alignment status between SPMCS and DBE workbook activities on NGP as the focus of this study. The findings of this study may help future alignment studies to extend the scope of alignment between content standards, instruction, assessment and learning materials. The findings revealed that alignment between SPMCS and DBE workbook activities on NGP is acceptable. However, the discrepancies were also identified, which should conscientise the DBE to pay attention to the discrepancies discussed in order to improve the quality in teaching and learning of mathematics in South Africa. The findings may help to strengthen the curriculum, as well as enhancing the quality of instruction; the development of assessments; and also teaching and learning materials.

Despite obtaining similar findings to those obtained by Hoadley and Galant (2016) on the investigation of alignment between CAPS and Grade 3 literacy and mathematics DBE workbooks, replicating this study with a wider scope is recommended. I therefore recommend similar studies to showcase the status of alignment for the entire DBE workbooks and other learning areas other than mathematics. Future alignment studies could also be extended to various components such as instruction, assessment and learning materials, in order to guide the teaching and learning of mathematics in the right direction. This may help since alignment has been proven to be beneficial to learner attainment and towards enhancing the education system (Biggs, 2014; Watermeyer, 2012). In conclusion, it is imperative that the development of DBE workbooks and other teaching and learning materials be cognitively aligned to the content standards.

REFERENCES

Adams, N.E. (2015). Bloom's taxonomy of cognitive learning objectives. *Journal of the Medical Library Association: JMLA, 103*(3), 152.

Addonizio, M., & Kearney, C.P. (2012). *Education reform and the limits of policy.* Kalamazoo, MI:Upjohn Institute for Employment Research.

Akaranga, S.I., & Makau, B.K. (2016). Ethical considerations and their applications to research: A case study of the University of Nairobi. *Journal of Educational Policy and Entrepreneurial Research*, *3*(12), 1-9.

Alexandrache, C. (2014). Journal reflexive, an instrument for student preparation in the teaching profession. *Procedia- Social and Behavioural Sciences, 149*, 20-24.

Anderson, C., & Gantz, J.F. (2013). Skills requirements for tomorrow's best jobs: Helping educators provide students with skills and tools they need. IDC, October.

Anney, V.N. (2014). Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)*, *5*(2), 272- 281.

Armes, J.W. (2016). Quantifying the qualitative: Increasing the reliability of subjective language assessments. *Master's Projects and Capstones, 338*, 1-34.

Ary, D., Jacobs, L.C., Irvine, C.K.S., & Walker, D. (2018). Introduction to research in education. Australia:Cengage Learning.

Asiamah, N., Mensah, H.K., & Oteng-Abayie, E. F. (2017). General, target, and accessible population: Demystifying the concepts for effective sampling. *The Qualitative Report, 22*(6), 1607- 1621.

Assaly, I.R., & Smadi, O.M. (2015). Using Bloom's taxonomy to evaluate the cognitive levels of master class textbook's questions. *English Language Teaching, 8*(5), 100-110.

Australian Council for Educational Research (2013). Formative Evaluation of Textbooks and Workbooks in South Africa. Report prepared for the DBE, Pretoria.

Baporikar, N. (Ed,). (2014). *Handbook of research on higher education in the MENA region: Policy and practice: policy and Practice.* United States of America: IGI Global.

Baird, J-A, Hopfenbeck, T.N., Newton, P., Stobart, G., & Steen-Utheim, A.T. (2014). *Assessment and learning: State of the field review.* Oslo: Knowledge Centre for Education.

Barbosa, A., & Vale, I. (2015). Visualization in pattern generalization: Potential and challenge. *Journal of the European Teacher Education Network*, *10*, 57-70.

Beatty, R. (2014). Exploring the power of growing patterns. What Works*?. Research into Practice. Research Monograph. 55,* 1-4.

Bernard, H.R., & Bernard, H.R. (2013). Social research methods: Qualitative and quantitative approaches. Los Angeles: Sage.

Bernhardt, V. L., & Bernhardt, V. (2013). *Data analysis for continuous school improvement*. New York: Routledge.

Beyene, K.A., Aspden, T., & Sheridan, J. (2016). Prescription medicines sharing: Exploration patients' belief and experiences. *Journal of Pharmaceutical Policy and Practice, 9*(1), 23.

Biggs, J.B. (2014). Constructive alignment in University teaching. *HERDSA Review of Higher Education, 1*, 5-22.

Bloom, B.S. (1956). Taxonomy of educational objectives handbook 1: The cognitive domain. New York: David McKay Co.

Bishop F.L., & Holmes, M.M. (2013). Mixed methods in CAM research: A systematic review of studies published in 2012. *Evidence-Based Complementary and Alternative Medicine,* 1-12.

Bryman, A. (2016). *Social research methods.* London: Oxford University Press.

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation?. *Qualitative Health Research, 26*(13), 1802-1811.

Capate, R.N.A., & Lapinid, M.R.C. (2015, March). Assessing the mathematics performance of grade 8 students as basis for enhancing instruction and aligning with K to 12 curriculum. *Proceedings of the De La Salle University (DLSU) Research Congress* (Vol.3).

Chilisa, B. (2011). *Indigenous research methodologies*. Los Angeles: Sage Publications.

Clough, S., & Montgomery, S. (2015). How ACT assessments align with state college and career readiness standards. From: http://www.discoveract aspire.org/pdf/ACT_Alignment-White-paper.pdf (accessed 6 April 2018).

Collocott, P., Dowse, C., Gerrard, P.A., & Maharaj, K. (2013). *Premier mathematics Grade 7 learner's book*. Pietermaritzburg: Shuter & Shooter.

Collymore, J.C. (2013). Enhancing student performance: Linking the Geography curriculum, instruction and assessment in the English speaking Caribbean.

Creswell, J.W., & Creswell, J.D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches.* Thousand Oaks: Sage Publications.

Creswell, J.W. (2015).*Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. New York: Pearson.

Creswell, J.W., & Clark, V.L. (2017). Designing and conducting mixed methods research. Thousand Oaks: Sage Publications.

Creswell, J.W., Plano Clark, V.L., Gutmann, M.L., & Hanson, W.E. (2003). Advanced mixed methods research designs. Handbook of mixed methods in social and behavioral research, 209, 240.

Daro, P., Hughes, G.B., & Stancavage, F. (2015). Study of the alignment of the 2015 NAEP mathematics items at Grades 4 and 8 to the common core state standards (CCSS) for mathematics.

Davis-Becker, S.L., & Buckendahl, C.W. (2013). A proposed framework evaluating alignment studies. *Educational Measurement, 32*(1), 23-33.

De Chesnay, M. (Ed.). (2015). *Nursing research using phenomenology: Qualitative designs and methods in nursing*. London: Springer Publishing Company.

Department of Basic Education. (2017). Mathematics in English Grade 7- Book 2 Term 3 &4. Pretoria: Department of Basic Education.

Department of Basic Education. (2017). Mathematics in English Grade 8 - Book 1 Term 1 &2. Pretoria: Department of Basic Education.

Department of Basic Education. (2017). Mathematics in English Grade 9 - Book 1 Term 1 &2. Pretoria: Department of Basic Education.

Department of Basic Education. (2013). *Workbook training manual*. Pretoria: Department of Basic Education.

Department of Basic Education. (2012a). *Report on the Annual National Assessment*, Pretoria. From: www.education.gov.za (accessed 10 April 2018).

Department of Basic Education. (2011). *Curriculum and assessment policy statement: Senior phase mathematics Grade 7-9*. Pretoria: Department of Basic Education.

Dwyer, C.A. (Ed.). (2017). *The future of assessment: Shaping teaching and learning*. London: Routledge.

Dzelzkaleja, L., & Kapenieks, J. (2016). Real-time color codes for assessing learning process. *Procedia-Social and Behavioral Sciences, 231,* 263-269.

Elfil, M., & Negida, A. (2017). Sampling methods in clinical research; an educational review. *Emergency, 5*(1).1-6.

Ennis, C.D. (2014). The role of students and content in teacher effectiveness. *Research Quarterly for Exercise and Sport, 85*(1), 6-13.

Duke Escobar, V.G. (2016). An international comparison study of the alignment between standards and assessment of pre-service elementary mathematics teacher preparation courses. From: http://scholarworks.boisestate.edu/td/1217 (accessed 25 November 2017).

Etikan, I., Musa, S.A., & Alkassim, R.S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1-4.

FitzPatrick, B., Hawboldt, J., Doyle, D., & Genge, T. (2015). Alignment of learning objectives and assessments in therapeutics courses to foster higher-order thinking. *American Journal of Pharmaceutical Education, 79*(1), 10.

Gargiulo, R. M., & Metcalf, D. (2017). *Teaching in today's inclusive classrooms: A universal design for learning approach*. Boston: Nelson Education.

Gibbs, K. (2012). The impact of common core state standards. *Symposium of School Leadership*, 1-13.

Gracin, D.G., & Matic, L.J. (2016). The role of mathematics textbooks in lower secondary education in Croatia. An Empirical study. *The Mathematics Educator, 16*(2), 31.

Hess, F. M., & McShane, M. Q. (Eds.). (2013). *Common core meets education reform. What it all means for politics, policy, and the future of schooling*. Amsterdam: Teachers College Press.

Higgins, R.M. (2013). Examining alignment: national and local assessments and the common core state standards in mathematics. *Electronic Theses and Dissertations, 617*.

Greive, E. L. (2012). Comparing alignment of a state test and district formative assessments with state content standards using three methods (Doctoral dissertation, The University of North Carolina at Chapel Hill). From: https//cdr.lib.unc.edu (accessed 15 November 2017).

Heale, R., & Forbes, D. (2013). Understanding triangulation in research. *Evidence-Based Nursing, 16*(4), 98-98.

Hoadley, U., & Galant, J. (2016). An analysis of the Grade 3 Department of Basic Education workbooks as curriculum tool. *South African Journal of Childhood Education*, *6*(1), 1-12.

Hutchings, P. (2016). Aligning educational outcomes and practices. *Occasional paper, 26.*

Hsu, H.Y., & Silver, E.A. (2014). Cognitive level of mathematics instructional tasks in a Taiwanese classroom: An examination of task sources. *Journal for Research in Mathematics Education, 45*(4), 460-496.

Irvine, J. (2017). A comparison of revised Bloom and Marzano's new taxonomy of learning. *Research in Higher Education Journal*. 33, 1-16.

Jenna, L. (2017). *100 ideas for primary teachers: Homework*. New York: Bloomsbury.

Johnson, B., & Christensen, L. (2008). Educational research: Quantitative, qualitative, and mixed approaches. California: Sage Publications.

Kalobo, L., & Toit, G.F.D. (2015). The use of mathematics taxonomy in developing statistical learning outcomes for Grade 12 learners. *International Journal of Education Sciences, 9*(3), 351-360.

Kalu, F.A., & Bwalya, J.C. (2017). What makes qualitative research good research? An exploratory analysis of critical elements. *International Journal of Social Science Research, 5*(2), 43-56.

Karuguti, W.M., Phillips, J., & Barr, H. (2017). Analysing the cognitive rigor of interprofessional curriculum using the depth of knowledge framework. *Journal of Interprofessional Care*, *31*(4), 529-532.

Kelly, J., Sadeghieh, T., & Adeli, K. (2014). Peer review in scientific publications: Benefits, critiques, & a survival guide. *EJIFCC, 25*(3), 227-243.

Khusainova, R.M., Shilova, Z.V., & Curteva, O.V. (2016). Selection of appropriate statistical methods for research results processing. *International Electronic of Mathematics Education, 11*(1), 303-315.

Klees, S.J., Samoff, J., & Stromquist, N.P. (Eds.). (2012). *The world bank and education: Critiques and alternatives* (Vol.14). Rotterdam: Springer Science & Business Media.

Korstjens, I., & Moser, A. (2018). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, *24*(1), 120-124.

Krippendorff, K. (2011). Agreement and information in reliability of coding. *Communication Methods and Measures, 5*(2), 93-112.

Leedy, P.D., & Ormrod, J.E. (2013). *Practical research: Planning & design.*10th Edition. Boston: Pearson.

Leung, K.C., Leung, F.K., & Zuo, H. (2014). A study of the alignment of learning targets and assessment to generic skills in the new senior secondary mathematics curriculum in Hong Kong. *Studies in Educational Evaluation, 43*, 115-132.

Lilly, J., Peacock, A., Shoveller, S., & Struthers, D.R. (2014) *Beyond levels: Alternative assessment approaches developed by teaching schools*. From: http://dera.ioe.ac.uk/eprint/20802 (accessed 23 July 2017).

Long, C., & Dunne, T. (2014). Mathematics curriculum and assessment: The role of taxonomies in the quest for coherence. *Pythagoras*, 35(2), 1-14.

El-Maaddawy, T., & Deneen, C.C. (2017). Outcomes-based assessment and learning: Trialling change in a postgraduate civil engineering course. *Journal of University Teaching & Learning Practices, 14*(1), 1-19.

Major, C.H., & Savin-Baden, M. (2012). *An introduction to qualitative research synthesis: Managing the information explosion in social science*. London: Routledge.

Marzano, R.J., & David, C. (2013). *Using common core standards to enhance classroom instruction & assessment*. United States of America: Solution Tree Press.

Marzano, R.J., & Kendall, J.S. (Eds.) (2006). *The new taxonomy of educational objectives*. Thousand Oaks: Corwin Press.

Mathews, C., Mdluli, M., & Ramsingh, V. (2014). The use of workbooks in South African Grade 3 mathematics classrooms. *South African Journal of Childhood Education, 4*(1), 80-94.

McKim, C.A. (2017). The value of mixed methods research: A mixed methods study. *Journal of Mixed Methods Research, 11*(2), 202-222.

Morrison, K.M., & Embretson, S.E. (2014). Using cognitive level to measure the psychometric properties of mathematics assessment items. *Multivariate Behaviour Research*, *49(3)*, 292-293.

Msimango, M.R. (2017). Teach and assess: A strategy for effective teaching and learning in economic and management sciences (Doctoral dissertation, university of the Free State). From: http://hdl.handle.net/11660/7745 (accessed 14 August 2017).

Ndlovu, M., & Mji, A. (2012). Alignment between South African mathematics assessment standards and the TIMSS assessment frameworks. *Pythagoras*, *33*(3), 1-9.

Newton, J.A., & and Kasten, S.E. (2013). Two models for evaluating alignment of state standards and assessments: Competing or complementary perspectives?. *Journal for Research in Mathematics Education, 44*(3), 550-580.

Ngulube, P., & Ngulube, B. (2015). Mixed methods research in the South African journal of economic and management sciences: An investigation of trends in the literature. *South African Journal of Economic and Management Sciences, 18*(1), 1-13.

Nurrahmi, H., Suryadi, D., & Fatimah, S. (2017, September). Students' algebraic thinking process in context of point and line properties. In *Journal of Physics: Conference Series* (Vol. 895, No. 1, p. 012085). IOP Publishing.

Oates, T. (2014). Why textbooks count. *A Policy Paper*. *Cambridge: University of Cambridge.*

O'Leary, Z. (2017). *The essential guide to doing your research project*. Thousand Oaks: Sage.

Phillips, P.P., & Stawarski, C.A. (2008). *Data collection: Planning for and collecting all types of data (*Vol.175*).* San Francisco: John Wiley & sons.

Polikoff, M.S., & Porter, A.C. (2014). Instructional alignment as a measure of teaching quality. *Educational Evaluation and Policy Analysis, 36*(4), 399-416.

Polikoff, M.S. (2015). How well aligned are textbooks to the common core standards in mathematics?. *American Educational Research Journal*, *52*(6), 1185-1211.

Polikoff, M.S., & Fulmer, G.W. (2013). Refining methods for estimating critical values for an alignment index. *Journal of Research on Educational Effectiveness, 6*(4), 380-395.

Ponce, O.A., & Pagan-Maldonaldo, N. (2015). Mixed methods research in education: Capturing the complexity of the profession. *International Journal of Educational Excellence. 1*(1), 111-135.

Porter, A.C. (2002). Measuring the content of instruction: Uses in research and practice. *Educational Researcher*, *31* (7), 3-14.

Resnick, D.B. (2015). What is ethics in research & why is it important*?. National Institute of Environmental Health Sciences*, *1*(10). From: https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm (accessed 23 January 2018)

Riet, A.M. (2015). The use of learning and teaching support material for classroom teaching: Intermediate phase (a study of four primary schools in Diepkloof, Soweto) (Doctoral dissertation).

Rothman, R., Slattery, J.B., Vranek, J.L., & Resnick, L.B. (2002). Benchmarking and alignment of standards and testing. *National Centre for Research on Evaluation, Standards and Student Testing.*

Salina, C., Girtz, S., & Eppinga, J. (2016). *Transforming schools through systems change*. London: Rowman & Littlefield.

Scheerens, J. (Ed). (2016). *Opportunity to learn, curriculum alignment and test preparation: A research review*. Switzerland: Springer.

Sireci, S., & Faulkner-Bond, M. (2014). Validity evidence based on test content. *Psicothema*, *26*(1), 100-107.

Smith, R.J. (2012). Alignment of intended learning outcomes, curriculum and assessment in a middle school science program. From: https://ro.ecu.edu.au/theses/489 (accessed 17 July 2017).

Smith, L.K., Hanks, J.H., & Erickson, L.B. (2017). Secondary Biology textbooks and national standards for English learners. *Science Education, 101*(2), 302-332.

Stroker, G., & Evans, M. (Eds). (2016). *Evidence-based policy making in the social sciences: Methods that matter*. Bristol : Policy Press.

Tannenbaum, R.J., Baron, P.A., & Kannan, P. (2015). Alignment between innovative summative assessment prototypes and the common core state standards: An exploratory investigation. *Research memorandum No. RM-15-07). Princeton, NJ: Educational Testing Service*, 1-16.

Thomas, G. (2017). *How to do your research project: A guide for students.* London: Sage Publications Ltd.

Tichapondwa, S.M. (2013). *Preparing your dissertation at a distance: A research guide.* Vancouver: Virtual University for small states of the Collonwealth.

From: http://www.sadc.int/files/3713/7821/2867/Dissertation_PDF.pdf. (accessed 17 July 2017).

Tran, D. (2016). Statistical association: Alignment of current U.S. High school textbooks with the common core state standards for Mathematics. *School Science and Mathematics, 116*(5), 286-296.

Troia, G. A., Olinghouse, N.G., Wilson, J., Stewart, K. A., Mo, Y., Hawkins, L., & Kopke, R. A. (2016). The common core writing standards: A descriptive study of content and alignment with a sample of former state standards. *Reading Horizons, 55*(3), 98-141.

Venkat, H., & Graven, M. (2017). *Changing teaching through a resources approach*. In *Improving Primary Mathematics Education, Teaching and Learning* (pp. 163-178). London: Palgrave Macmillan.

Vercellini, P., Buggio, L., Vigano, P., & Somigliana, E. (2016). Peer review in medical journals: Beyond quality of reports towards transparency and public scrutiny of the process. *European Journal of Internal Medicine*, *31*, 15-19.

Watermeyer, R. (2012). Curriculum alignment, articulation and the formative development of the learner. *IB literature review report Cardiff, wales: International Baccalaureate.*

Watty, K., Jackling, B., & Wilson, R.M. (Eds.). (2014). *Personal transferable skills in accounting education*. London: Routledge.

Webb, N.L. (1997). Criteria for alignment of expectations and assessment in mathematics and science education. Research Monograph No.6.

Webb, N.L. (2007). Issues related to judging the alignment of curriculum standards and assessments. *Applied Measurement in Education*, *20*(1), 7-25.

Zajda, J. (2015). *National-building and history education in a global culture.* In national-building and history education in a global culture (pp 185-191). Dordrecht: Springer.

Zapf, A., Castell, S., Morawietz, L., & Karch, A. (2016). Measuring inter-rater reliability for nominal data – which coefficients and confidence intervals are appropriate?. *BMC Medical Research Methodology, 16*(1), 93.

Zhuge, H. (2016). *Muliti-dimensional summarisation in cyber-physical society*. Amsterdam: Morgan kaufmann.

Zmazek, B., Lipovec, A., Pesek, I., Zmazek, V., Senveter, S., Regvat, J., & Prnaver, K. (2012). What is an e-textbook?. *Metodicki Obzori*: casopis za odgojno-obrazovnu teoriju i praksu, 7(15), 127-139.

Zohrabi, M. (2013). Mixed method research: instruments, validity, reliability and reporting findings. *Theory & Practice in Language Studies*, *3*(2), 254-262.

APPENDIX A: APPROVAL FROM THE UNIVERSITY OF LIMPOPO

University of Limpopo
Faculty of Humanities
Executive Dean
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4895, Fax: (015) 268 3425, Email:richard.madadzhe@ul.ac.za

DATE: 17 October 2017

NAME OF STUDENT: QHIBI, AD
STUDENT NUMBER: [200405140]
DEPARTMENT: MEd – Mathematics Education
SCHOOL: Education

Dear Student

FACULTY APPROVAL OF PROPOSAL (PROPOSAL NO. FHDC2017/2520)

I have pleasure in informing you that your MEd proposal served at the Faculty Higher Degrees Meeting on 16 September 2017 and your title was approved as follows:

TITLE: ALIGNMENT BETWEEN SENIOR PHASE MATHEMATICS CONTENT STANDARDS AND NUMERIC AND GEOMETRIC PATTERNS WORKBOOK ACTIVITIES

Note the following:

Ethical Clearance	**Tick One**
Requires no ethical clearance Proceed with the study	
Requires ethical clearance (Human) (TREC) (apply online) Proceed with the study only after receipt of ethical clearance certificate	√
Requires ethical clearance (Animal) (AREC) Proceed with the study only after receipt of ethical clearance certificate	

Yours faithfully

TS Maoto RS

Prof RS Maoto,
Executive Dean: Faculty of Humanities

Director: Prof TM Mabasa
Supervisor: Mr ZB Dhlamini
Co-supervisor: Dr B Chigonga
Dr KM Chuene

Finding solutions for Africa

APPENDIX B: ETHICAL CLEARANCE FROM THE UNIVERSITY OF LIMPOPO

UNIVERSITY OF LIMPOPO

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4029, Fax: (015) 268 2306, Email:Abdul.Maluleke@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE CLEARANCE CERTIFICATE

MEETING:	**07 February 2018**
PROJECT NUMBER:	**TREC/10/2018: PG**
PROJECT:	
Title:	Alignment between senior phase Mathematics Content Standards and Numeric and Geometric Patterns' Workbook Activities.
Researcher:	AD Qhibi
Supervisor:	Mr ZB Dhlamini
Co-Supervisors:	Dr B Chigonga Dr KM Chuene
School:	Education
Degree:	Masters in Mathematics Education

PROF TAB MASHEGO
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111-031**

Note:
i) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.**
ii) **The budget for the research will be considered separately from the protocol.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

Finding solutions for Africa

APPENDIX C: LETTER SEEKING PERMISSION FROM THE DEPARTMENT OF BASIC EDUCATION

University of Limpopo

School of Education, Department of Mathematics Science and Mathematics Education Private Bag X1106 Sovenga DMSTE Building Office 1011

Tel: 0152683883 Email: zwelithini.dhlamini@ul.ac.za

MINISTER OF EDUCATION

MRS ANGIE MOTSHEGA

DEPARTMENT OF BASIC EDUCATION

Struben Street

PRETORIA

0001

SUBJECT: REQUEST FOR PERMISSION TO CONDUCT MEd RESEARCH TITLE: ALIGNMENT BETWEEN SENIOR PHASE MATHEMATICS CONTENT STANDARDS AND NUMERIC AND GEOMETRIC PATTERNS' WORKBOOK ACTIVITIES: SOUTH AFRICA.

Dear Madam,

I hereby requesting permission to conduct a Master's Degree study on an alignment study between South African Senior Phase Mathematics Content Standards and Numeric and Geometric Patterns' DBE Workbook Activities, with the purpose of calculating the degree of alignment between them. I am registered with the University of Limpopo under the supervision of Mr Dhlamini Z.B and co-supervision of Dr K. Chuene and Dr B. Chigonga. The University of Limpopo subscribes to high professional ethics. Attached is the approval letter from the Faculty of Humanities Higher Degrees Committee, Proposal and Ethical clearance certificate.

After completion, I will provide the Department with a copy of the full research report.

Hoping for a positive response and thanking you in advance.

Yours Faithfully

Qhibi Agnes Dulu (Student No: 200405140)
duluagnes@yahoo.com/ 0720457 457
Mr Z.B. Dhlamini (Supervisor)
Dr K. Chuene (Co-supervisor)
Dr B. Chigonga (Co-supervisor)

APPENDIX D: LETTER OF APPROVAL FROM THE DEPARTMENT OF BASIC EDUCATION

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

Private Bag X895, Pretoria, 0001, Sol Plaatje House, 222 Struben Street, Pretoria, 0002, South Africa
Tel.: (012) 357 3000, Fax: (012) 323 0601, www.education.gov.za

Ref no: ODG-0531/18-20/04/2018
Enquires: Mr AT Tshirado
Tel: 012 357 3656
Email:Tshirado.T@dbe.gov.za

Ms AD Qhibi
167 Springbok Street
Numbi Park
HAZYVIEW
1287

By email: duluagnes@yahoo.com

Dear Ms Qhibi

RESPONSE TO A REQUEST FOR PERMISSION TO USE DBE WORKBOOKS

The Department of Basic Education (DBE) received your request to use DBE workbooks for research purposes.

The research request is approved on condition that you, as the applicant of the research, adheres to the conditions set in the research protocol of the DBE and to the ethical conduct of using research data and information.

It is emphasised that the information collected from the DBE should solely be used for the purpose of this research. The Research Co-ordination, Monitoring and Evaluation (RCME) Directorate will liaise with the relevant DBE section on your behalf to set out dates and times for the interviews.

We recommend that you submit this letter as evidence that the DBE is aware of your research and also, that you share the findings of the research with the DBE at the conclusion of your study.

Yours sincerely

MR HM MWELI
DIRECTOR-GENERAL
DATE: 20/04/2018

Basic Education • Basiese Onderwys • Imfundvo Lesisekelo • Fundoasisekelo • Mfundo Eyisisekelo • Imfundo esiSiseko • Dyondzo ya le Hansi
Pfunzo ya Mathomo • Thuto ya Motheo • Thuto ya Motheo • Thuto e Potlana

APPENDIX E: APPOINTMENT LETTER FOR CONTENT ANALYSTS

Enquiries: Qhibi A.D.
Email: duluagnes@yahoo.com
Cell: 072 0457 457

P.O. BOX 1287
BUSHBUCKRIDGE
1280

25 May 2018

MATHEMATICS SES

SUBJECT: APPOINTMENT AS CONTENT ANALYST ON A RESEARCH PROJECT

Dear Sir/Madam

My name is Qhibi Agnes Dulu and I am a student at the University of Limpopo. I wish to conduct a study for my Master's degree under the title: **Alignment between Senior Phase Mathematics Content Standards and Numeric and Geometric Patterns' Workbook Activities.** The study will be conducted under the supervision of Mr Dhlamini Z.B.

You are hereby invited and requested to share your mathematics expertise in analysing content for my study. Your task will be mainly to categorise content and DBE workbook activities according to their cognitive levels. Comprehensive training on data coding will be done during the process of data collection. You will be notified as soon as logistics for the activity are finalised.

Be advised that no monetary benefits are attached to the activity. Your confidentiality is guaranteed and your participation is voluntary. The final research report will be available at the University of Limpopo library.

Please confirm your participation on or before the **21st of May 2018** by returning the consent form.

Hoping that my request will be highly considered

Yours Faithfully

Qhibi Agnes Dulu
University of Limpopo

APPENDIX F: CONSENT FORM FOR CONTENT ANALYSTS

Responsibilities

These are:

- to identify the depth of knowledge of the content standards and DBE workbook activities;
- to review the criteria of content focus; and
- to analyse, evaluate and interpret given data.

This letter confirms that I have read and understood the responsibilities of the content analyst, and hereby accept the appointment as a content analyst. I am willing to participate in the study voluntarily.

____________________	____________________	____________________
Name of participant	Participant's Signature	Date

APPENDIX G1: GRADE 7 CONTENT IDENTIFIED ON NGP'S CONTENT STANDARDS

Content standards on NGP		**Content identified**
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.	
	• not limited to sequences involving a constant difference or ratio.	
	• of learner's own creation.	
	• represented in tables.	
2. Describe and justify the general rules for observed relationships between numbers in own words.		

APPENDIX G2: GRADE 8 CONTENT IDENTIFIED ON NGP'S CONTENT STANDARDS

Content standards on NGP		**Content identified**
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.	
	• not limited to sequences involving a constant difference or ratio.	
	• of learner's own creation.	
	• represented in tables.	
	• represented algebraically.	
2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.		

APPENDIX G3: GRADE 9 CONTENT IDENTIFIED ON NGP'S CONTENT STANDARDS

Content standards on NGP		**Content identified**
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.	
	• not limited to sequences involving a constant difference or ratio.	
	• of learner's own creation.	
	• represented in tables	
	• represented algebraically	
2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.		

APPENDIX H1: GRADE 7 CONTENT IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	Activity	Content identified
WS 65	1	
WS 65	2	
WS 65	S	
WS 66	1	
WS 66	PS	
WS 67	1	
WS 67	PS	
WS 68	1	
WS 68	2	
WS 68	PS	
WS 69	1	
WS 69	PS	
WS 70	1	
WS 70	2	
WS 70	PS	
WS 71a	1	
WS 71b	PS	
WS 114	1	
WS114	2&3	
WS 114	PS	
WS 115	1	
WS 115	2&3	
WS 115	PS	
WS 116	1	
WS 116	PS	
WS 117a	1	
WS 117b	PS	

APPENDIX H2: GRADE 8 CONTENT IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	Activity	Content identified
WS 27a	1;2&4	
WS 27a	3	
WS 27a	5	
WS 27a	PS a	
WS 27a	PS b	
WS 27b	1	
WS 27b	2	
WS 27b	3	
WS 27b	4	
WS 27b	5	
WS 27b	PS a	
WS 27b	PS b	

APPENDIX H3: GRADE 9 CONTENT IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	**Activity**	**Content identified**
WS 27	**1;2&3**	
WS 27	**4**	
WS 27	**5**	
WS 27	**PS**	
WS 28	**1**	
WS 28	**2&3**	
WS 28	**PS**	

APPENDIX I1: GRADE 7 COGNITIVE LEVELS IDENTIFIED ON NGP'S CONTENT STANDARDS

Content standards on NGP		**Cognitive levels identified**			
		Knowledge	**Routine procedures**	**Complex procedures**	**Problem solving**
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.				
	• not limited to sequences involving a constant difference or ratio.				
	• of learner's own creation.				
	• represented in tables.				
2. Describe and justify the general rules for observed relationships between numbers in own words.					

APPENDIX I2: GRADE 8 COGNITIVE LEVELS IDENTIFIED ON NGP'S CONTENT STANDARDS

<table>
<tr><th colspan="2">Content standards on NGP</th><th colspan="4">Cognitive levels identified</th></tr>
<tr><th colspan="2"></th><th>Knowledge</th><th>Routine procedures</th><th>Complex procedures</th><th>Problem solving</th></tr>
<tr><td rowspan="5">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td><td>• represented in physical or diagram form.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• not limited to sequences involving a constant difference or ratio.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• of learner's own creation.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• represented in tables.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• represented algebraically.</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.</td><td></td><td></td><td></td><td></td></tr>
</table>

APPENDIX I3: GRADE 9 COGNITIVE LEVELS IDENTIFIED ON NGP'S CONTENT STANDARDS

<table>
<tr><th colspan="2">Content standards on NGP</th><th colspan="4">Cognitive levels identified</th></tr>
<tr><th colspan="2"></th><th>Knowledge</th><th>Routine procedures</th><th>Complex procedures</th><th>Problem solving</th></tr>
<tr><td rowspan="5">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td><td>• represented in physical or diagram form.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• not limited to sequences involving a constant difference or ratio.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• of learner's own creation.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• represented in tables.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>• represented algebraically.</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.</td><td></td><td></td><td></td><td></td></tr>
</table>

APPENDIX J1: GRADE 7 COGNITIVE LEVELS IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	Activity	Cognitive levels identified			
		Knowledge	Routine procedures	Complex procedures	Problem solving
WS 65	1				
WS 65	2				
WS 65	S				
WS 66	1				
WS 66	PS				
WS 67	1				
WS 67	PS				
WS 68	1				
WS 68	2				
WS 68	PS				
WS 69	1				
WS 69	PS				
WS 70	1				
WS 70	2				
WS 70	PS				
WS 71a	1				
WS 71b	PS				
WS 114	1				
WS114	2&3				
WS 114	PS				
WS 115	1				
WS 115	2&3				
WS 115	PS				
WS 116	1				
WS 116	PS				
WS 117a	1				
WS 117b	PS				

APPENDIX J2: GRADE 8 COGNITIVE LEVELS IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	Activity	Cognitive levels identified			
		Knowledge	Routine procedures	Complex procedures	Problem solving
WS 27a	1;2&4				
WS 27a	3				
WS 27a	5				
WS 27a	PS a				
WS 27a	PS b				
WS 27b	1				
WS 27b	2				
WS 27b	3				
WS 27b	4				
WS 27b	5				
WS 27b	PS a				
WS 27b	PS b				

APPENDIX J3: GRADE 9 COGNITIVE LEVELS IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	Activity	Cognitive levels identified			
		Knowledge	Routine procedures	Complex procedures	Problem solving
WS 27	1;2&3				
WS 27	4				
WS 27	5				
WS 27	PS				
WS 28	1				
WS 28	2&3				
WS 28	PS				

APPENDIX K1: GRADE 7 RANGES OF PATTERNS IDENTIFIED ON NGP'S CONTENT STANDARDS

Content standards on NGP		**Ranges of patterns identified**
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.	
	• not limited to sequences involving a constant difference or ratio.	
	• of learner's own creation.	
	• represented in tables.	
2. Describe and justify the general rules for observed relationships between numbers in own words.		

APPENDIX K2: GRADE 8 RANGES OF PATTERNS IDENTIFIED ON NGP'S CONTENT STANDARDS

Content standards on NGP		**Ranges of patterns identified**
1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:	• represented in physical or diagram form.	
	• not limited to sequences involving a constant difference or ratio.	
	• of learner's own creation.	
	• represented in tables.	
	• represented algebraically.	
2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.		

APPENDIX K3: GRADE 9 RANGES OF PATTERNS IDENTIFIED ON NGP'S CONTENT STANDARDS

<table>
<tr><th colspan="2">Content standards on NGP</th><th>Ranges of patterns identified</th></tr>
<tr><td rowspan="5">1. Investigate and extend numeric and geometric patterns looking for relationships between numbers, including patterns:</td><td>• represented in physical or diagram form.</td><td></td></tr>
<tr><td>• not limited to sequences involving a constant difference or ratio.</td><td></td></tr>
<tr><td>• of learner's own creation.</td><td></td></tr>
<tr><td>• represented in tables.</td><td></td></tr>
<tr><td>• represented algebraically.</td><td></td></tr>
<tr><td colspan="2">2. Describe and justify the general rules for observed relationships between numbers in own words or in algebraic language.</td><td></td></tr>
</table>

APPENDIX L1: GRADE 7 RANGES OF PATTERNS IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	Activity	Ranges of patterns
WS 65	1	
WS 65	2	
WS 65	S	
WS 66	1	
WS 66	PS	
WS 67	1	
WS 67	PS	
WS 68	1	
WS 68	2	
WS 68	PS	
WS 69	1	
WS 69	PS	
WS 70	1	
WS 70	2	
WS 70	PS	
WS 71a	1	
WS 71b	PS	
WS 114	1	
WS114	2&3	
WS 114	PS	
WS 115	1	
WS 115	2&3	
WS 115	PS	
WS 116	1	
WS 116	PS	
WS 117a	1	
WS 117b	PS	

APPENDIX L2: GRADE 8 RANGES OF PATTERNS IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	Activity	Ranges of patterns
WS 27a	1;2&4	
WS 27a	3	
WS 27a	5	
WS 27a	PS a	
WS 27a	PS b	
WS 27b	1	
WS 27b	2	
WS 27b	3	
WS 27b	4	
WS 27b	5	
WS 27b	PS a	
WS 27b	PS b	

APPENDIX L3: GRADE 9 RANGES OF PATTERNS IDENTIFIED ON NGP'S DBE WORKBOOK ACTIVITIES

Worksheet	Activity	Ranges of patterns
WS 27	1;2&3	
WS 27	4	
WS 27	5	
WS 27	PS	
WS 28	1	
WS 28	2&3	
WS 28	PS	

APPENDIX M1: GRADE 7 CONTENT MATRIX ON NGP

	GRADE 7 MATHEMATICS CONTENT ON NUMERIC AND GEOMETRIC PATTERNS	CONTENT ANALYST CODING				TOTAL
		Knowledge	Routine Procedures	Complex Procedures	Problem Solving	
PATTERNS, FUNCTIONS AND ALGEBRA						
Numeric and Geometric Patterns						
1	Investigation and extension of numeric and geometric patterns.					
2	Description of the general rule of patterns in words.					
	Total cognitive score points					
	Total content proportions					
	Proportions % grand totals					

APPENDIX M2: GRADE 8 CONTENT MATRIX ON NGP

	GRADE 8 MATHEMATICS CONTENT ON NUMERIC AND GEOMETRIC PATTERNS	CONTENT ANALYST CODING				TOTAL
		Knowledge	Routine Procedures	Complex Procedures	Problem Solving	
PATTERNS, FUNCTIONS AND ALGEBRA						
Numeric and Geometric Patterns						
1	Investigation and extension of numeric and geometric patterns.					
2	Description of the general rule of patterns in words or in algebraic language.					
	Total cognitive score points					
	Total content proportions					
	Proportions % grand totals					

APPENDIX M3: GRADE 9 CONTENT MATRIX ON NGP

	GRADE 9 MATHEMATICS CONTENT ON NUMERIC AND GEOMETRIC PATTERNS	CONTENT ANALYST CODING				TOTAL
		Knowledge	Routine Procedures	Complex Procedures	Problem Solving	
PATTERNS, FUNCTIONS AND ALGEBRA						
Numeric and Geometric Patterns						
1	Investigation and extension of numeric and geometric patterns.					
2	Description the general rule of patterns in words or in algebraic language.					
	Total cognitive score points					
	Total content proportions					
	Proportions % grand totals					

APPENDIX N1: GRADE 7 ASSESSMENT MATRIX ON NGP

	DBE WORKBOOK 2 GRADE 7 ACTIVITIES ON NGP	CONTENT ANALYST CODING				TOTAL
		Knowledge	Routine Procedures	Complex Procedures	Problem Solving	
PATTERNS, FUNCTIONS AND ALGEBRA						
Numeric and Geometric Patterns						
1	Investigation and extension of numeric and geometric patterns.					
2	Description of the general rule of patterns in words.					
	Total cognitive score points					
	Total content proportions					
	Proportions % grand totals					

APPENDIX N2: GRADE 8 DBE WORKBOOK ACTIVITIES MATRIX ON NGP

	DBE WORKBOOK 1 GRADE 8 ACTIVITIES ON NGP	CONTENT ANALYST CODING				TOTAL
		Knowledge	Routine Procedures	Complex Procedures	Problem Solving	
PATTERNS, FUNCTIONS AND ALGEBRA						
Numeric and Geometric Patterns						
1	Investigation and extension of numeric and geometric patterns.					
2	Description of the general rule of patterns in words or in algebraic language.					
	Total cognitive score points					
	Total content proportions					
	Proportions % grand totals					

APPENDIX N3: GRADE 9 DBE WORKBOOK ACTIVITIES MATRIX ON NGP

	DBE WORKBOOK 1 GRADE 9 ACTIVITIES ON NGP	CONTENT ANALYST CODING				TOTAL
		Knowledge	Routine Procedures	Complex Procedures	Problem Solving	
PATTERNS, FUNCTIONS AND ALGEBRA						
Numeric and Geometric Patterns						
1	Investigation and extension of numeric and geometric patterns.					
2	Description of the general rule of patterns in words or in algebraic language.					
	Total cognitive score points					
	Total content proportions					
	Proportions % grand totals					

APPENDIX O: GRADES 7 TO 9 - SUMMARY OF CONTENT STANDARDS' PROPORTIONS

Grade	Content standards on NGP	Cognitive level				Total
		Knowledge	Routine Procedure	Complex Procedure	Problem Solving	
7	1					
	2					
Total Cognitive Score Points						
Total Content Proportions						
Proportions % Grand Totals						
8	1					
	2					
Total Cognitive Score Points						
Total Content Proportions						
Proportions % Grand Totals						
9	1					
	2					
Total Cognitive Score Points						
Total Content Proportions						
Proportions % Grand Totals						

APPENDIX P: GRADES 7 TO 9 - SUMMARY OF DBE WORKBOOK ACTIVITIES' PROPORTIONS

	GRADE 7				**GRADE 8**				**GRADE 9**			
	DBE WORKBOOK ACTIVITIES PROPORTIONS											
	Knowledge	**Routine Procedure**	**Complex Procedure**	**Problem Solving**	**Knowledge**	**Routine Procedure**	**Complex Procedure**	**Problem Solving**	**Knowledge**	**Routine Procedure**	**Complex Procedure**	**Problem Solving**
Total cognitive score points												
Total content proportions												
Proportions % grand totals												

APPENDIX Q: CERTIFICATE OF EDITING

BERNICE BRADE EDITING Member of the Professional Editors' Guild

FREELANCE WRITER, PROOF READER AND EDITOR
WEB RESEARCHER AND RESEARCH STRATEGIST
ENGLISH SPECIALIST
ESTABLISHED 1987

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8 December 2018

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South Africa

To whom it may concern

This letter serves to confirm that **in December 2018** I did the proofreading and the language editing for the Dissertation of

QHIBI AGNES DULU

Student Number 200405140

Titled: ***ALIGNMENT BETWEEN SENIOR PHASE MATHEMATICS CONTENT STANDARDS AND NUMERIC AND GEOMETRIC PATTERNS' WORKBOOK ACTIVITIES***

This document is being submitted in fulfilment of the requirements for the degree

MASTER OF EDUCATION in MATHEMATICS EDUCATION

In the FACULTY OF HUMANITIES

(School of Education)

At the UNIVERSITY OF LIMPOPO

I have proofread and edited the work from the introductory pages through to the list of References, but have not been asked to edit the Appendices. This editing principally involves proofreading, language, style, punctuation and grammar editing; and also checking the text for clarity of meaning, sequence of thought and expression and tenses. I have noted any inconsistencies in thought, style or logic, and any ambiguities or repetitions of words and phrases, and have corrected those errors which creep into all writing. I have written the corrections on the hard copy and have returned the document to the author, who is responsible for inserting these. Please note that this confirmation refers only to editing of work done up to the date of this letter and does not include any changes which the author or the supervisor may make later.

8 December 2018

Bernice McNeil BA Hons, NSTD

Member of the English Academy of Southern Africa

Member of the Classical Association of South Africa