The contribution of Grades 4 – 6 Mathematics textbooks towards the development of conceptual understanding of two-dimensional (2-D) shapes

TM Mosiane

10 962 964

Dissertation submitted in fulfillment of the requirements for the degree *Magister Educationis* in Mathematics Education

at the Potchefstroom Campus of the North-West University

Supervisor: Prof. HD Nieuwoudt

Month and year of submission: September 2014

Month and year of graduation: September 2014

ACKNOWLEDGEMENTS

My deep and hearfelt gratitude goes to the following persons who walked this journey with me through differing stages and in various capacities:

- Dr Susan Nieuwoudt as critical reader
- Prof. Petro du Preez as critical reader
- Prof. Carisma Nel as critical reader
- Prof. Hercules Nieuwoudt as supervisor.

~ ~ ~

The staff discount received as financial assistance from the NWU-Potchefstroom Campus towards my studies is hereby acknowledged. Opinions expressed and conclusions arrived at are those of the researcher and author and cannot in any way be attributed to the NWU Potchefstroom Campus.

H C Sieberhagen *Translator and Editor*

SATI no 1001489 *082 3359846*

hettie.sieberhagen@nwu.ac.za *0182994554*

CERTIFICATE

Issued on 05 May 2014

I hereby declare that I have edited the language of the following dissertation submitted by Mr T M Mosiane

The contribution of Grades 4 - 6 Mathematics textbooks towards the development of conceptual understanding of two-dimensional (2-D) shapes

DISSERTATION SUBMITTED FOR THE DEGREE MEd

AT THE
POTCHEFSTROOM CAMPUS
OF THE
NORTH-WEST UNIVERSITY

H. Sieberhagen

H C Sieberhagen
SATI number **1001489**
ID 4504190077088
Hettie.Sieberhagen@nwu.ac.za

05 May 2014
Potchefstroom

1 Gerrit Dekker Street

POTCHEFSTROOM

2531

13 May 2014

Mr Tom Mosiane

NWU (Potchefstroom Campus)

POTCHEFSTROOM

CHECKING OF BIBLIOGRAPHY

Hereby I declare that I have checked the technical correctness of the Bibliography of Mr Tom Mosiane according to the prescribed format of the Senate of the North-West University.

Yours sincerely

Prof CJH LESSING

ABSTRACT

The aim of this study was to investigate the contribution of grades 4 – 6 Mathematics (English LOLT) textbooks on the development of conceptual understanding of 2-D shapes. A review of literature concerning the textbooks, readability, the language of learning and teaching (LOLT), curriculum and conceptual understanding, was conducted in order to frame a better understanding of the key words, build the statement of the title as well as find and review relevant literature.

The contribution of the textbooks as tools towards the development of conceptual understanding of 2-D shapes, is understood by the researcher to either be present or not present at all. It cannot be satisfied halfway because the purpose of the textbook is full compliance with the CAPS. Thus, the contribution of the textbooks is evidenced and confirmed by full compliance to the relevant intended curriculum requirements and refuted by partial or no compliance at all.

A pragmatic worldview, with both a document and conceptual analytical research design methodology as strategy of inquiry, was implemented for this qualitative research to study the state and level of the English LOLT, curriculum and research compliance in five of eight approved series of grades 4 - 6 Mathematics textbooks. The five series identified for evaluation were the only ones in use by the English LOLT schools in the greater Potchefstroom area.

The ordinary English language of the textbooks was analysed with the Gunning Fog Readability Test (GFRT); the Mathematics topics, concepts and skills of 2-D shapes were analysed and evaluated for compliance with the specification of content and clarification notes of the CAPS, as well as the Van Hiele theory levels 0 and 1 descriptors. The GFRT was proposed by a research advisor. It was used electronically online and the similar but separate and different CAPS-based and Van Hiele theory-based measuring instruments were designed and used by the researcher to analyse and evaluate the textbooks.

The findings of this research contradict the evaluation of the DBE that resulted in the approval of eight series of textbooks from which five were identified and studied, and suggest that all five approved series of grades 4 – 6 Mathematics textbooks evaluated are not “fit for their purpose” on the topics, concepts and skills of 2-D shapes. Only 20% of the five series of textbooks per grade in the intermediate phase are readable with ease and understanding and can thus contribute to the conceptual understanding of 2-D shapes. All fifteen textbooks are not CAPS compliant according to the focus of this research, and can therefore not be

relied on to interpret and give meaning to the intended curriculum. They are also not Van Hiele compliant and thereby demonstrate that the world renowned research findings of the Van Hieles have either not been incorporated in the textbooks' teaching and learning method and pedagogical approach or simply not fully incorporated.

Three recommendations follow from the findings of the research. The first one is that the readability of every textbook be evaluated when they are considered for approval and adoption into the national catalogue. One or more of the existing foreign readability measuring instruments can be used for this purpose; however the development and use of a special South African tailored and owned English as a First Additional Language instrument is strongly suggested to ensure correct, consistent and appropriate English LOLT level for the grade and age group of the learners.

Secondly, for CAPS compliance, the DBE must design and utilise much more methodical, in-depth and stringent evaluation processes according to the topics, concepts and skills in the CAPS documents. Thus textbooks should be scored on specific topics, concepts and skills and not in general terms as it seems to be the case currently. There must be specific minimum CAPS progression level(s) in percentage and measurement set for acceptable progression levels between any two consecutive grades in terms of topics, concepts and skills, the content area and the entire grade. Furthermore, only 100% CAPS compliant textbooks must be approved for inclusion in the national catalogue of textbooks from which the teachers of school choose textbooks for their learners.

Thirdly and lastly, that the world renowned Van Hiele Theory of Geometric Thought be incorporated into the South African Mathematics curriculum policies, practice and research as part of strengthening South African Mathematics education.

OPSOMMING

Die bydrae van grade 4 – 6 Wiskunde handboeke tot die ontwikkeling van konseptuele begrip van 2-D vorms

Die doel van hierdie studie was om die bydrae van die Wiskunde (Engels TVOL) handboeke van grade 4 tot 6 op die ontwikkeling van konseptuele begrip van 2-D vorms te ondersoek. ‘n Oorsig van die literatuur oor handboeke, leesbaarheid, die taal van onderrig en leer (TVOL), kurrikulum en konseptuele begrip was uitgevoer ten einde ‘n beter begrip van sleutel woorde te beraam, die verklaring van die titel te bou, sowel as om relevante literatuur te bou en te hersien.

Die bydrae van die handboeke as intrumente tot die ontwikkeling van konseptuele begrip van 2-D vorms word deur die navorser verstaan as iets wat òf teenwoordig òf nie teenwoordig is nie. Dit kan nie halfpad teenwoordig wees nie want die doel van die handboek is die volle nakoming van die Kurrikulum en Assesseringsbeleidsverklaring (KABV). Die bydrae van die handboeke is dus bewys deur die volle nakoming van die relevante voorgenome kurrikulum vereistes, en weerlê deur gedeeltelike of geen voldoening aan almal nie.

‘n Pragmatiese wêreldbeskouing, met beide ‘n dokument en konseptuele analitiese navorsingsontwerpmetode as strategie van ondersoek was vir hierdie kwalitatiewe navorsing geïmplementeer om die toestand en vlak van die Engelse TVOL, kurrikulum en nakoming van navorsing te bestudeer in vyf van agt goedgekeurde Wiskunde reekse van grade 4 tot 6. Die vyf reekse van grade 4 tot 6 wat vir evaluering geïdentifiseer was, was die enigstes in gebruik deur die Engelse TVOL skole in die groter Potchefstroom area.

Die gewone Engelse taal is ontleed met die Gunning Fog Leesbaarheid toets (GFLT); die Wiskundeonderwerpe, -konsepte en -vaardighede van 2-D vorms in die handboeke is ontleed en geëvalueer vir nakoming van die spesifikasies van die inhoud en verduidelikende aantekeninge van die KABV, as ook die Van Hiele teorie vlakke 0 en 1 se beskrywings. Die GFLT is deur ‘n navorsingsadviseur voorgestel en dit is elektronies aanlyn gebruik. Die soorgelyke maar afsonderlike en verskillende KABV-gebaseerde en Van Hiele teorie-gebaseerde meetinstrumente is deur die navorser ontwerp en gebruik om die handboeke te ontleed en evalueer.

Die bevindings van hierdie navorsing weerspreek die evaluering van die DBO wat gelei het tot die goedkeuring van agt reeks handboeke, waaruit vyf geïdentifiseer en bestudeer is, en stel voordat al vyf goedgekeurde Wiskunde handbook reekse van grade 4 tot 6 wat

geëvalueer was, “nie geskik is vir die doel nie” sover dit betref onderwerpe, konsepte en vaardighede ten opsigte van 2-D vorms. Slegs 20% van die vyf reekse van handboeke per graad in die intermediêrefase kan gemaklik en met begrip gelees word, en kan dus ‘n bydrae tot die konseptuele begrip van 2-D vorms lewer. Geen van die vyftien handboeke voldoen aan die KABV met betrekking tot die fokus van hierdie navorsing nie, en kan dus nie op staatgemaak word om interpretasie en betekenis te gee aan die voorgenome kurrikulum nie. Hulle voldoen ook nie aan Van Hiele nie, en daardeur toon hulle dat die wêreldbekende bevindinge van die Van Hieles foutief of (of glad nie) opgeneem is in die handboeke se onderrig en leer metodes en opvoedkundige benadering nie.

Drie aanbevelings volg uit die bevindinge van hierdie navorsing. Die eerste een is dat die leesbaarheid van elke handbook geëvalueer en oorweeg word vir goedkeuring en aanvaarding van die handboek in die nasionale katalogus. Een of meer van die bestaande buitelandse leesbaarheidmeetinstrumente kan vir hierdie doel gebruik word, maar die ontwikkeling en gebruik van ‘n spesifieke Suid Afrikaanse maatstaf van Engels as eerste addisionele taal word sterk aanbeveel om korrekte, konsekwente en gepaste Engels TVOL te verseker vir die graad en ouderdomsgroep van die leerders.

Tweedens, vir KABV nakoming, moet die DBO ‘n baie meer metodiese, in-diepte en streng evalueringsproses volgens die onderwerpe, konsepte en vaardighede in die KABV dokumente gebruik. Handboeke moet aangeteken word op spesifieke onderwerpe, konsepte en vaardighede en nie in die algemeen soos dit tans gebeur nie. Daar moet spesifieke minimum KABV vorderingsvlakke in presentasie en meting bepaal word wat aanvaarbaar sou wees tussen enige twee opeenvolgende grade sover dit onderwerpe, konsepte en vaardighede, die area van inhoud en die hele graad betref. Verder, slegs handboeke wat 100% aan KABV voldoen moet goedgekeur word vir insluiting in die nasionale katalogus.

Derdens en laastens, dat die wêreldbekende Van Hiele teorie van Meetkundige Denke in die Suid-Afrikaanse Wiskunde-onderwys ingesluit word.

KEY WORDS

- Learner textbooks in Mathematics
- Readability of the learning material in Mathematics
- Language of learning and teaching
- Curriculum design and implementation
- Van Hiele Theory of Geometric Thought
- Teaching-learning activities
- Level descriptors-learner responses
- Conceptual understanding of 2-D shapes
- Visual, verbal / written, drawing, logical and application skills
- LTSM evaluation
- Intermediate Phase Mathematics

LIST OF ABBREVIATIONS

ANA	Annual National Assessments
2-D	Two-Dimensional
CAPS	Curriculum Assessment and Policy Statements
DBE	Department of Basic Education
DVDs	Digital Video Discs
FAL	First Additional Language
GFRT	Gunning Fog Readability Test
GFRI	Gunning Fog Readability Index
GFRIs	Gunning Fog Readability Indices
HL	Home Language
LOLT	Language of Learning and Teaching
NCS	National Curriculum Statement
NCTM	National Council of Teachers of Mathematics
NQF	National Qualifications Framework
NSC	National Senior Certificate
S 1	Series 1
S 2	Series 2
S 3	Series 3
S 4	Series 4
S 5	Series 5
SANQF	South African National Qualifications Framework
SMT	Senior Management Team
TIMMS	Trends in International Mathematics and Science Study

TABLE OF CONTENTS

LIST OF APPENDICES

Page

LIST OF TABLES

Page

CHAPTER 1
INTRODUCTION AND OVERVIEW

1.1 ORIENTATION

From 2012 the two National Curriculum Statements for Grades R - 9 and Grades 10 - 12 have been combined into a single document simply known as the National Curriculum Statement (NCS) Grades R - 12 (DBE, 2011b: ii, 3). The NCS Grades R - 12 emerged from the strengthening and repacking of its outcomes-based predecessor that had three design features, the critical and developmental outcomes, learning outcomes, and assessment standards (DoE, 2002a: 5; DBE, 2010b). It represents a policy statement for learning and teaching in South African schools and is strongly supported by the Curriculum and Assessment Policy Statements (CAPS) for all approved subjects (DBE, 2011b: ii, 3). It has already been phased in at grades R - 3 and grade 10 in 2012, grades 4 - 6 and 11 in 2013 and grades 7 - 9 and 12 follow last in 2014 (DBE, 2010b;2012d: 6).

Instead of the critical and developmental outcomes of the outcomes-based curriculum, the NCS Grades R - 12 has general aims of the South African Curriculum, which include the purposes of the curriculum, the principles on which it is based and its eight specific aims (DBE, 2010c: 2; 2011b: 4 - 5). All learning areas and programmes are now known as subjects, and each subject in each phase has a single, comprehensive and concise CAPS document that provides details on which content teachers ought to teach and assess on a grade-by-grade and subject-by-subject basis (DBE, 2010b; 2010c: 2). The CAPS has been embarked on to improve the quality of teaching and learning (DBE, 2010b). It focuses on the content that must be taught per term and the required number and type of assessment tasks each term for each subject, in order to ensure that teachers and learners have a clear understanding of the topics that must be covered in each subject (DBE, 2010b).

The outcomes-based curriculum relied on various learning support materials and teacher development programmes as tools, to interpret and give meaning to the learning outcomes and assessment standards (DoE, 2002a: 11 - 12, 14). It did not identify any one specific learning support material as primary and crucial to quality learning and teaching, but instead promoted teacher self-developed learning support materials, textbooks and other published learning and teaching materials**.** However, the NCS Grades R - 12 specifically identifies textbooks as crucial in the achievement of quality learning and teaching and thereby re-emphasise their primary role in the classroom (DBE, 2010b). Hence, in its first newsletter of 2010, the National Department of Basic Education confirms the reasons why the textbooks

are important in teaching and learning; what the role of the textbook is; how the textbook should be utilised; why the importance of the textbooks should be stressed to the learners and their parents, and lastly, what the national catalogue of textbooks is (DBE, 2010c: 6 - 7).

However, all the actions of re-emphasis and declarations related to textbooks, do not equate to improving their impact and quality towards the development of conceptual understanding in any subject, and Mathematics in particular. Instead, a more deliberate effort is needed towards producing high quality textbooks with potential to support quality learning and teaching. Thus, the same or even more effort, resources and attention expended on the new NCS Grades R - 12 policy statement should be expended on ensuring the quality of the textbooks by making sure that the contents of each textbook are compliant with the CAPS. This compliance is with respect to the content areas, general and specific foci, the specification of content and the topics, concepts and skills contained there-in.

1.2 PROBLEM STATEMENT

The Department of Basic Education (DBE) declared that textbooks had to be used by teachers and learners to enhance their teaching and learning, and that only textbooks meeting the criteria for good textbooks would be selected and placed in the catalogue (DBE, 2010a: 6 - 7). Hence, in 2012, the DBE approved eight grades 4 - 6 Mathematics (English LOLT) textbook titles of seven different publishers for final confirmation into the national catalogue of both learner and the teacher texts, from which the schools have selected for implementation in 2013 (DBE, 2012a: 12 - 13; 2012c).

The DBE first provided the publishers and authors with its screening and evaluation tool, comprising seven evaluation criteria, as a framework for developing and writing the textbooks. However, the textbook evaluation form used by the DBE has not been specifically tailored to evaluate the compliance of the textbooks in detail, with regard to the evaluation criteria set forth. In particular, compliance with the topics, concepts and skills in the CAPS; the English (LOLT) readability level, as well as the pedagogical approach and teaching and learning (instructional) design seem not to be determinable through the evaluation form (DBE, 2012b: 1 – 9 / Appendix L). As a result, there is no adequate assurance that the grades 4 - 6 Mathematics textbooks as tools give full, equal and accurate meaning to the Mathematics content areas and the general and specific content foci as expressed by the topics, concepts and skills to be achieved. Furthermore, teachers and schools may be given a false hope and sense of assurance that all textbooks included in the national catalogue are good Mathematics textbooks that engage learners in quality learning activities and purposeful teaching practices.

Consequently, there is a possibility that the approved grades 4 - 6 Mathematics (English LOLT) textbooks are not CAPS compliant and thus fail to fully, equally and accurately interpret and give meaning to the topics, concepts and skills related to 2-D shapes. Consequently, they fail to contribute towards the development of the conceptual understanding of 2-D shapes and cannot support quality learning and teaching.

1.3 RATIONALE FOR THE STUDY

The 2011 Trends in International Mathematics and Science Study (TIMMS) showed that South African learners have the lowest performance from 21 middle-income countries that participated (Beinstein et al., 2013a: 3). The earlier TIMMS, other international educational studies and even local assessments testing competency, reflected a consistently poor performance of South African Mathematics learners. The poor performance is often attributed to teacher incompetence, teacher complacency, lack of parental and community involvement and general weakness in the education system (Beinstein et al., 2013b: 3). In fact, the outcomes-based curriculum itself was also blamed for the poor learner performance and teacher frustrations (DBE, 2012d: 6).

However, it would be ignorant and inexcusable to apportion blame to everyone and everything else except the textbooks which may be an important shortcoming in the teaching and learning environment. The link between the curriculum policy statement, the textbooks, learning and teaching in the classroom and the results of assessments is expressed in the model of intended, potentially implemented, implemented and attained curriculum of Johansson (2005b: 120). The curriculum model of Johansson (2005b: 120) suggests that the textbooks should be the next in line to be scrutinized after the curriculum reviews in 2000 and 2009 from which the NCS Grade R - 12 and CAPS emerged.

The researcher in this study contends that it is best and prudent to earnestly give attention to all the aspects of the educational system, including the curriculum model of Johannson (2005b: 120) as a whole, in order to avoid missing important linkages. Hence, the Mathematics curriculum development in South Africa should first scrutinise the Mathematics subject CAPS to check on its completeness and expressed intent, followed by its accurate interpretation and fulfilment through the textbooks. When the Mathematics subject CAPS and the textbooks are correctly in place and fulfilling their roles, the next scrutiny should fall on the curriculum implementation by the teachers and learners in the classroom long before looking at the attained curriculum. Assuming that the Mathematics CAPS is in place, the focus should earnestly be on textbooks.

It might be argued that even the seemingly perfect CAPS can show weaknesses later and that nothing is ever perfect for a long time. However, in a link like the curriculum model of Johansson (2005b: 120), it is crucial to identify the weaknesses and rectify them immediately so as to inject confidence, credibility and quality. Precluding the NCS Grades R - 12 and then the textbooks in the accountability stakes for the poor Mathematics results, will build a certain level of confidence in the national education system and give assurance of some parts of the Mathematics curriculum being fully functional and credible. Attention can then focus on the non-functional or weaker parts, particularly the classroom implementation of the Mathematics curriculum.

As part of the strategy of monitoring and improving the level and quality of basic education in South Africa, the Annual National Assessments (ANA) are carried out yearly for Grades 1 - 6 and 9, with a specific focus on the English language literacy and Mathematics in grades 4 – 6 and 9 (DBE, 2012d: 1 - 2). According to the report on the ANA, the choice of the priority ANA subjects, English Home and First Additional Languages and Mathematics, for monitoring has been informed by the worldwide recognition of language Literacy and Mathematics as key foundational skills that predispose learners to effective learning in all the fields of knowledge (DBE, 2012d: 1 - 2). It is the sincere belief of the researcher that the research is in support of not only the ANA, but also of any similar and related endeavours, and that the results and recommendations of this research will assist to improve the level and quality of Mathematics education in particular.

1.4 CONTEXT OF THE STUDY

The study started in 2009 before the outcomes-based curriculum was disbanded in favour of NCS Grades R - 12 in 2012. It was prompted by a comparison that the researcher made in 2008 between the grades 4 - 9 outcomes-based curriculum textbooks and the assessment standards of learning outcome 3 on shape and space (geometry). In particular, the researcher thought then that the contents of the textbooks were not quite compliant with the assessment standards concerning 2-D shapes.

Introduced in 1997, the outcomes-based curriculum was reviewed for the first time in 2000 and for a second time in 2009, after which findings were published (DBE, 2011b: ii). Hence, the NCS Grades R - 12 is not only built on the previous outcomes-based curriculum but also updated it. It maintains the assessment standards as specification of content, but provides clearer specification of what is to be taught and learnt on a term-by-term basis in the form of the clarification notes, also called teaching guidelines. The clarification notes accompanying the specification of content is evidence of strengthening of the curriculum. The other

evidence of the strengthening of the curriculum is the national, instead of provincial approval and inclusion of textbooks into a national catalogue.

After the introduction of the outcomes-based curriculum in 1997, two reviews in 2000 and 2009 and strengthening, the researcher contends that the next step in line with the Johansson's model of intended, potentially implemented, implemented and attained curriculum is to strengthen the potentially implemented curriculum represented by the textbooks.

1.5 OBJECTIVES OF THE STUDY

The objectives of this qualitative research was to evaluate the contribution of a series of five grades 4 - 6 Mathematics (English LOLT) learner textbooks presently used in the South African Public Schools, toward the development of the conceptual understanding of 2-D shapes. The results of the study provide reliable information and data from which implications, suggestions and recommendations for future possible strategies if and where needed, will be done for the development of Mathematics teaching and learning in the schools.

In the evaluation process, literature was used to describe a curriculum in general including the NCS Grades R - 12 specifically; the perceptions and the role of textbooks in a curriculum; the readability of a document; progression and compliance of subject content with the topics, concepts and skills; the curriculum model of Johansson (2005b: 120) as well as the Van Hiele Theory of Geometric Thought.

The objectives of the study are encompassed in the following research question:

- What contribution, if any, do the grades 4 - 6 Mathematics (English LOLT) learner textbooks make towards developing the conceptual understanding of 2-dimensional (2-D) shapes?

The sub-questions and objectives implored to obtain answers to the research question, are as follows:

- Are the learner textbooks readable with ease and understanding for the grades and years of education of the learners in each of the grades 4 - 6, with regard to the topics, concepts and skills of 2-D shapes?
- Does the beginning of the intermediate phase grade 4 series of learner textbooks show progression from grade 3 to grade 4 in the topics, concepts and skills of 2-D shapes as given in the CAPS for grade 3?

- Are the presentations, explanations, diagrams, teaching and learning exercises and activities in the learner textbooks compliant with the topics, concepts and skills of 2-D shapes in the CAPS for each specific grade 4 - 6?
- Does the end of the intermediate phase grade 6 series of learner textbooks show progression to grade 7 in the topics, concepts and skills of 2-D shapes as given in the CAPS for grade 7?
- Are the presentations, explanations, diagrams, teaching and learning exercises and activities in the learner textbooks compliant with the developmental path of the Van Hiele theory of geometric development?

1.6 RESEARCH DESIGN

A combined conceptual analytical and document analysis research design was chosen and used for this qualitative study (Nieuwenhuis, 2010: 71). Since textbooks are existing secondary documents, the design classification for this study was that of secondary textual sources of data (Mouton, 2001: 144,175; McMillan 2000: 263). A series of five grades 4 - 6 Mathematics (English LOLT) learner textbook documents were subjected to ordinary English language, conceptual and pedagogical documents analysis.

A total of 15 grades 4 - 6 Mathematics (English LOLT) learner textbooks from five series of textbooks were evaluated in the following manner:

1.6.1 For their English language text reading difficulty level and its appropriateness for learners in each of the three grades, by determining the Gunning Fox Readability Index (GFRI) of each learner textbook through the use of a free online software tool;

1.6.2 For their level of curriculum content and CAPS compliance through the CAPS-based measuring instruments;

1.6.3 For their level of CAPS progression from the foundation phase and towards the senior phase through the CAPS-based measuring instruments;

1.6.4 For the Van Hiele theory level 0 and 1 compliance through the Van Hiele theory level 0 and level 1-based measuring instruments.

1.7 OUTLINE AND ORGANISATION OF THE DISSERTATION

This dissertation comprises five chapters, including this one.

Chapter 1 presents the researcher's approach to and rationale for the study on the contribution of grades 4 - 6 Mathematics (English LOLT) textbooks towards the development of conceptual understanding of 2-D shapes. This chapter provides a general orientation and

background, the problem statement, rationale and context of the study as well as the research design.

Chapter 2, titled “learner textbooks and Mathematics teaching and learning”, explores literature and positions pertaining to the study in terms of teaching and learning practices generally used in Mathematics and more specifically the teaching and learning of geometry. Particularly, the model of intended, potentially implemented, implemented and attained curriculum is expounded and used as a theoretical framework for the study, together with the Van Hiele Theory of Geometric Thought.

Chapter 3, titled research design and methodology, describes in detail the research process followed, including further illumination on the design from Chapter 1 and then methodological approach in the study. This chapter also includes the criteria for effective grades 4 - 6 Mathematics (English LOLT) textbooks in line with the research.

Chapter 4, titled research results, presents the results and findings of the research in tabular form of raw data and percentages, as well as explanations of how the data were obtained. All this is done sequentially according to the objectives and includes brief discussions and conclusions.

Chapter 5 presents the summary, conclusions and recommendations drawn from the results and the whole research study. An overview, overall conclusions, reflections and implications are also presented.

CHAPTER 2

LEARNER TEXTBOOKS AND MATHEMATICS TEACHING AND LEARNING

2.1 INTRODUCTION

Textbooks play a vital role in the teaching and learning of the Mathematics subject, and as part of the curriculum (DBE, 2010a: 6).

The purpose of this chapter is to explore the literature with regard to curriculum in general, the South African schools curriculum and the Mathematics curriculum in particular. Furthermore, textbooks and Mathematics teaching and learning, will also be explored in the light of the curriculum model of the intended, potentially implemented, implemented and attained curriculum postulated by Johansson (2005b: 120). The model will then be applied to the Mathematics curriculum concerning the space and shape (geometry) Mathematics content knowledge and subject matter around the conceptual understanding of 2-D shapes in the intermediate phase grades 4 - 6.

The chapter also presents the current South African Schools Curriculum, the NCS Grades R - 12, essentially as one falling under the traditional curriculum paradigm, and specifically the behaviourist curriculum theory (Jacobs, 2011a: 38, 50). The NCS Grades R - 12 has the aim, scope, content, method and assessment as its components for each subject, and these components form an important element of the planning and design process of any lesson to influence the quality of teaching and learning (DBE, 2011c: ii).

Furthermore, the chapter presents and describes the definition of curriculum that is relevant and will be used in the study; the nature, elements and practice of the curriculum. It describes the Mathematics textbook as a secondary artefact, teacher and instrument; the potentially implemented curriculum and the curriculum implementation itself, before concluding about the benefits of the evaluation of the Mathematics textbooks for the curriculum and the South African Mathematics education for grades 4 - 6.

2.2 QUESTIONS OF CURRICULUM AND THE CURRICULUM MODEL

2.2.1 Orientation

There are three orders of questions regarding curriculum, namely, concerning the nature, the elements, and the practice of curriculum (Dillon, 2009: 344). The first question on the nature of curriculum inquires after the essence and substance of curriculum, namely, what it is and after its properties and character, namely, what it is like (Dillon, 2009: 344). The second

question on the elements of curriculum questions the things of which the implemented curriculum is composed (Dillon, 2009: 345) while the third question on the practice and enactment of curriculum concerns itself with the implementation of the curriculum, particularly with regard to teachers locating themselves within the elements of the curriculum and asking questions on how to think and act for and during implementation (Dillon, 2009: 348 - 349).

2.2.2 The nature of curriculum

The term curriculum has a wide range of meanings in different instances and contexts as used by different role players in the educational field (Stein et al, 2007: 321; Cangelosi, 2007: 131).

For educational policy decision makers and designers, curriculum refers to expectations for educational teaching and learning, including the intentions, aims and goals laid out in official policy documents or frameworks of education at the national educational system level, and called the intended curriculum by Johansson (2005b: 120), or written curriculum by Stein et al (2007: 321). In this first instance and context, curriculum is the National Curriculum Statement (NCS) Grades R - 12.

For educational researchers and practitioners, curriculum refers to the teaching and learning material resources and any other organised resources, designed to be used by teachers and learners in the classroom, and specifically called the potentially implemented curriculum by Johansson (2005b: 120) and interpreted curriculum by Stein et al (2007: 321). In this second instance and context, curriculum is the textbooks, workbooks, educational charts, programmes, software, DVDs, etc.

For a National Senior Certificate (NSC) learner or a Bachelor of Arts / Science / Commerce university student, or any secondary school or university personnel involved in curriculum control and advising, curriculum could refer to the totality of the subjects that the student has to register for and pass through-out her / his studies to complete the qualification, specifically called the National Senior Certificate Curriculum or Bachelor of Arts / Science / Commerce Curriculum respectively in this case (Jacobs, 2011a: 32). Apart from carrying a specific number of credits to be completed and having to be studied over a specific duration, every qualification is placed on a specific level on the South African National Qualification Framework (SANQF). Hence, the National Senior Certificate curriculum is a 130 credit qualification, studied over a three (3) year period for grades 10 - 12 and is at National Qualifications Framework (NQF) Level 4, while the Bachelor of Arts / Science / Commerce curriculum is a 360 – 600 credit qualification, also studied over a three (3) year period after

grade 12 and is at NQF level 7 or 8 (DBE, 2011c: 52; DBE, 2009: 2 - 3, 5; DoE, 2007: 23, 24). In this third instance and context, curriculum is the contents of the certificate, diploma or degree qualification in all its specifications, outcomes and requirements.

The term curriculum could also refer to the sequence of a specific subject's courses or modules as well as other school-sponsored functions like clubs, competitions or even outings, meant to encourage students in the subject (Cangelosi, 2007: 130), or only the specific subject's course or module content as it appears in the written documents including the aims and objectives thereof. Depending on the subject in question, curriculum in this case would specifically be called the Mathematics Subject Curriculum or the Accounting Subject Curriculum according to the subject (Jacobs, 2011a: 32; Cangelosi, 2007: 131).

Curriculum could still be what actually takes place in the classroom as carried out by teachers and learners, in the form of strategies employed, practices and activities, referred to as the enacted curriculum by Gehrke et al. (cited by Stein et al., 2007: 321) or the implemented curriculum by Johansson (2005b: 120). In this fifth instance and context, curriculum refers to the intentions and objectives at the level of the teacher and the classroom, and includes lesson plans, components of the lesson plan, activities and assessment (Johansson 2005b: 120).

The impact of the enacted or implemented curriculum on the students as evidenced by the subject matter knowledge, ideas, constructs and schemas and values possessed by the learners, is the other meaning or context of a curriculum, called the attained or experienced curriculum as referred to by Valverde et al. and Gehrke et al. (cited by Stein et al., 2007: 321), and Johansson (2005b: 120). In this sixth and last instance, curriculum is the product, results or outcomes of the classroom activities emanating from the intentions and objectives of the teachers.

2.2.2.1 The research purpose and the South African curriculum and context

For the purpose of this research, a holistic definition and meaning of the nature of curriculum derived from the six (6) different contexts as used by different role players in the educational field will be used. Hence, a Mathematics curriculum will be defined as a collection of interrelated Mathematics plans and desirable experiences pertaining to teaching and learning Mathematics, at the national, institutional or organisational and classroom levels (Jacobs, 2011a: 33). Since the intermediate phase grades 4 – 6, which the research focuses on, do not form a qualification on their own without grades R - 3 and grades 7 - 9, the third context and definition of curriculum as the totality of subjects to be registered to complete a

qualification does not form part of the inclusive definition. Hence, the Mathematics curriculum definition encompasses only five (5) of the six (6) different meanings and contexts in which the term curriculum is used in order to truly reflect all the aspects and details that are important for this research. This definition also agrees with the curriculum model of intended, potentially implemented, implemented and attained curriculums, postulated by Johansson (2005b: 120).

In the context of the Republic of South Africa, planning at national level involves the research, writing and publication of the expectations for teaching and learning laid out in the National Curriculum Statement (NCS) Grades R - 12, which represents the national education policy statement for learning and teaching by the national government (DBE, 2011a: 7 - 8; 2011b: 4). The NCS Grades R – 12 comprises the Curriculum and Assessment Policy Statement (CAPS), the national policy document on programme and promotional requirements of the NCS Grades R - 12 and the national protocol for assessment Grades R - 12 (DBE, 2011b: 4; DBE, 2011a: 7 – 8; DBE, 2011c: 1), and is therefore the intended or written curriculum. For the purpose of this research, the term intended curriculum will be used exclusively.

Planning at the institutional and organisational levels concerns the interpretation and translation of the CAPS, writing and publication of the textbooks, workbooks and other organisedteaching and learning material resources by public and private publishing institutions and organisations. The textbooks, workbooks and learning and teaching resource materials are tools for the interpretation of the intended curriculum, designed to be used by the Mathematics teachers and learners in the classroom, and are comprehensively the potentially implemented or interpreted curriculum (DoE, 2002a: 11 - 12, 14; DoE, 2003a: 61; Johansson, 2005b: 120; Stein et al., 2007: 321). For the purpose of this research, the term potentially implemented curriculum will be used exclusively.

Planning at the school and classroom level involves defining the objectives of lessons, finding information about topics, concepts and skills, and deciding on suitable teaching and assessment methods by teachers (Jacobs, 2011a: 33). At this level of planning, the teachers should first decide what changes they want to bring about as a result of their teaching. Their envisaged results must be stated and described in the form of aims and objectives which can be achieved and assessed, including the cognitive levels and demands at which the learners must achieve and the use of the appropriate language for each grade (DBE, 2012d: 6; Jacobs, 2011b: 67). Planning here also means starting and maintaining a teacher's file which involves the recording and planning documents used by the teacher, like the formal

programme of assessment, evidence of learner assessment and performance; all formal assessment tasks and marking guidelines; annual teaching plan or work schedule; textbook used and other resources (DBE, 2011c: ii).

The national, organisational and classroom level plans are there to make sure that the teaching and learning process involves the necessary material and subject content that includes the desirable knowledge, skills, moral values and successful careers (Jacobs, 2011a: 33).

2.2.2.2 The Mathematics subject curriculum background

Mathematics is one of the many subjects approved and listed by the NCS Grades R - 12 and has its own Curriculum and Assessment Policy Statement (CAPS) documents for the foundation phase grades R - 3, intermediate phase grades 4 - 6, senior phase grades 7 - 9 and the further education and training (FET) band grades 10 - 12 (DBE, 2011c: 61; DBE, 2009: 31, 33). The CAPS is the policy document stipulating the aim, scope, content and assessment for each subject listed in the NCS Grades R – 12 (DBE, 2011c: ii); hence, the intended Mathematics curriculum is laid out in the Mathematics subject CAPS document according to the different phases and grades within the phase by the national government.

For the purpose of this research on “the contribution of grades 4 - 6 Mathematics textbooks towards the development of conceptual understanding of two-dimensional (2-D) shapes”, and specifically for this Chapter 2 titled “learner textbooks and Mathematics teaching and learning”, the intended Mathematic curriculum is laid out in the intermediate phase grades 4 - 6 Mathematics subject CAPS document.

The intermediate phase Mathematics CAPS document provides textbook authors and teachers with four sections in its table of contents, namely the introductory, the content specification, content clarification and assessment guidelines sections (DBE, 2011b: 2). The introductory section includes a background, overview, general aims of the South African curriculum and teaching and learning time allocations for all subjects. The content specification section includes the definition of Mathematics, specific aims, specific skills, focus of content areas or Mathematics content knowledge (subject matter), weighting of content areas and the specification of content to show progression in the phase, which includes Numbers, Operations and Relationships; Patterns, Functions and Algebra; Space and Shape (geometry); Measurement and Data Handling (DBE, 2011b: 2). Of the five (5) intermediate phase grades 4 - 6 Mathematics content areas, the space and shape (geometry) mathematics content area is the focus of this research.

The content clarification section includes the allocation of teaching time per topic per term for grades 4 - 6; clarification notes with teaching guidelines; clarification of Mathematics content for grades 4 - 6 and academic schooling terms one to four individually; while the assessment guideline section includes the types of assessment; informal or daily assessment; formal assessment; recording and reporting; moderation of assessment and the general aspects and matters (DBE, 2011b: 2).

The intended Mathematics curriculum concerning the space and shape Mathematics content knowledge and matter around the conceptual understanding of 2-D shapes in grades 4 - 6 as found in the intermediate phase grades 4 - 6 Mathematics CAPS document includes the general aims of the South African National Curriculum, the specific aims and skills for the teaching and learning of Mathematics, Mathematics content area of space and shape and its corresponding general content focus and specific content focus (DBE, 2011b: 4 - 6).

The general aims of the South African National Curriculum include that the NCS Grades R - 12 gives expression to the knowledge, skills and values worth learning, and ensures that learners acquire and apply knowledge and skills that are meaningful to their own lives, thereby promoting the idea of grounding knowledge in local contexts, while being sensitive to global imperatives (DBE, 2011b: 4). Furthermore, the NCS Grades R - 12 serves the purpose of equipping learners with knowledge, skills and values necessary for self-fulfilment and meaningful participation in society as citizens of a free country; providing access to higher education; facilitating the transition of learners from educational institutions to the workplace and providing employers with a sufficient profile of a learner's competences (DBE, 2011b: 4).

The NCS Grades R - 12 is based on the principles of social transformation; active and critical learning; high knowledge and high skills; progression; human rights, inclusivity, environmental and social justice; valuing indigenous knowledge systems; credibility, quality and efficiency (DBE, 2011b: 4).

The aims include, amongst others, to produce learners that are able to identify and solve problems and make decisions, using critical and creative thinking; work effectively as individuals and with others as members of a team; organise and manage themselves and their activities responsibly and effectively; collect, analyse, organise and critically evaluate information; communicate effectively using visual, symbolic and / or language skills in various modes; use science and technology effectively and critically showing responsibility towards the environment and the health of others; demonstrate an understanding of the world as a

set of related systems by recognising that problem solving contexts do not exist in isolation (DBE, 2011b: 5).

The specific aims for the teaching and learning of Mathematics include the development of deep conceptual understandings in order to make sense of Mathematics, and the acquisition of specific knowledge and skills necessary for the application of Mathematics to physical, social and mathematical problems; the study of related subject matter and further study in Mathematics (DBE, 2011b: 8). The general content focus declares that "the study of space and shape improves understanding and appreciation of the pattern, precision, achievement and beauty in natural and cultural forms" and "focuses on the properties, relationships, orientations, positions and transformations of two-dimensional (2-D) shapes and three-dimensional (3-D) objects" (DBE, 2011b: 10).

The corresponding specific content focus stipulates that the learners' experience of space and shape in the phase moves from recognition and simple description to classification and more detailed descriptions of characteristics and properties of 2-D shapes and 3-D objects; that learners should be given opportunities to draw 2-D shapes and make models of 3-D objects, as well as describe locations, transformations and symmetry (DBE, 2011b: 10). The Space and Shape phase overview declares that the main progression in this content area is achieved by a focus on new properties and characteristics of 2-D shapes and 3-D objects in each grade, and that learners are given opportunities to identify and describe the characteristics of 2-D shapes and 3-D objects and to develop their abilities to classify these (DBE, 2011b: 21).

Based on its prescription of the aim, scope, content and assessment for each subject through the CAPS document; detailed planning at all levels as well as promotion of constitutional values of inclusivity and valuing indigenous knowledge systems, the NCS Grades R - 12 itself is underpinned by the behaviourist theory and specifically the curriculum model of Tyler (1949) (Jacobs, 2011a: 50). The CAPS prescriptions, namely, aims, objectives, scope or context, content, method and assessment, form the five (5) main components of the planning and design process of a course or a lesson and influence the quality of teaching and learning (Jacobs, 2011a: 50).

2.2.3 The elements of the curriculum in general

2.2.3.1 Orientation

The second question of curriculum, namely, the components or elements of the curriculum, is about the things that constitute or compose the implemented curriculum (Dillon, 2009: 345).

There are seven components of the implemented curriculum, each with a categorical question, and all of these altogether being further questions of curriculum, namely, who, whom, what, where and when, why, how and what results. They all focus on the things that educators have to think and act about in doing the curriculum (Dillon, 2009: 345 - 6). In principle, the seven questions operate equally and simultaneously in constituting any given instance of implementing the curriculum, formed of all seven together and can be connected, in one interrogative sentence to ask: who should teach what to whom, why should the teaching take place, where, when and how should it take place and with what expectations or purpose should the teaching take place? (Dillon, 2009: 347).

- **Who** refers to the teacher and specifically, who the teacher should be, encompassing and comprehending all possible questions about the teacher, his / her personality, background, training, qualifications, characteristics, traits, personality, role, etc. except for his / her actions (Dillon, 2009: 345).

- **Whom** refers to the learner, and specifically, who teaches whom or who should be taught? The characteristics, dispositions and qualities of the learner are questioned with regard to what makes a person a learner, how a learner learns and which characteristics, dispositions and qualities of the learner the teacher should take into consideration while teaching? (Dillon, 2009: 345).

- **What** refers to the subject-matter or content, specifically, the characteristics of subject-matter, its nature and content, materials and format, including the standard in terms of "what should be taught?", the hoary "what knowledge is of most worth?" and the enduring questions of "who should be taught what?", "what should be taught to whom, for which purpose, and in which circumstance?" (Dillon, 2009: 346)

- **Where** and **when** refer to the milieu, specifically all the questions of time, timing and place, circumstance, surrounding conditions, contexts, environments, eras, successively larger circles surrounding the curricular activity, that includes the classroom, school, community, society (Dillon, 2009: 346).

- **Why** or **to what end**, refers to the aim, specifically all the questions of educational purposes, goals, objectives, aspirations, intents, ends in view, and the like. What is the point of the teacher teaching the subject to his / her learner in the circumstance? (Dillon, 2009: 346)

- **How** refers to the activity. It is a question of means, methods and actions which are divided into learner action and teacher action, with educational primacy given to the learner (Dillon, 2009: 346). Additionally, it is also a question of complementary action, viz., the interaction between how a learner should act, how a teacher should act and how the teacher and the learner should interact (Dillon, 2009: 346). How a learner should act is about what the learner must do, be, have in order to learn the subject-matter or content. How a teacher should act is about what the teacher must do so that a learner can do that which a learner must do in order to learn the subject-matter or content (Dillon, 2009: 346). How the teacher and learner should interact primarily focuses on the subject-matter, in the circumstance within which the learning and teaching is taking place and with the specific aim in mind (Dillon, 2009: 346). Essentially, the question is "how should a teacher teach the subject-matter to his / her learner in the circumstance with the end in view?"

- **What comes from the activity or who learns what** refers to the result. Something necessarily comes from the interaction of the learner and the teacher over the subject-matter in the circumstance with the specific intention. However, what comes and how can it exactly be told? Furthermore, when the learner will have accomplished the intents of the curriculum, what will he / she look like? How will the accomplished person be seen to act, feel, think, and live (behavioural, affective, cognitive, lifestyle changes)? In general, who is the educated person? (Dillon, 2009: 346 - 347)

2.2.3.2 Elements of the Mathematics curriculum: General and specific content foci

The intended curriculum of doing the Mathematics of the 2-D shapes has nouns that describe which Mathematics or "what" must be done, as well as a number of action verbs which describe "how" the Mathematics must be performed (Van de Walle, 2013: 14). Hence, amongst the seven elements of the implemented curriculum listed and postulated by Dillon (2009: 345), only the "what" and "how" are critically important to addressing the research question of the contribution of grades 4 - 6 Mathematics textbooks towards the development of conceptual understanding of 2-D shapes.

The "what" specifically refers to the grades 4 - 6 Mathematics content knowledge and subject-matter, skills and values on the conceptual understanding of 2-D shapes, prescribed by the intended Mathematics curriculum in the grades 4 - 6 Mathematics CAPS document, and then interpreted and represented in the potentially implemented Mathematics curriculum in the grades 4 - 6 Mathematics textbooks. The "what" refers to the characteristics, nature, content, materials, format and standard of Mathematics in terms of "what should be taught?" or "what knowledge, skills and values are most valuable to be taught, for which purpose, and

in which circumstance?" (Dillon, 2009: 346). The words properties, relationships, orientations, positions and transformations are the nouns, either referring to places (in the case of 'positions'); qualities (in the case of 'properties', 'relationships' and 'orientations') or to activities (in the case of 'transformations') of the geometric figures (Oxford, 2010: 999; DBE, 2011b: 14 - 16).

The properties of geometric figures are the characteristics, qualities and features that they possess, which are typical or unique to only them, interesting, especially good and important; their relationships are the way in which they behave towards one another, are connected or even related to one another and to their environment; their orientations refer to the directions in which they face relative to other figures and their environment in general; their positions refer to the place where they are located, meant to be or correct place in the environment with respect to the group or class and their environment, and their transformations refer to their complete changes in position, orientations and relationships with respect to one another, the class or group and the environment (Oxford, 2010: 235, 539, 1030, 1165, 1187, 1229).

The "how" as the activity, specifically refers to means, methods, actions and experiences of both the teacher and the learner, partly prescribed by the intended curriculum in the grades 4 - 6 Mathematics CAPS document, interpreted and then represented in the potentially implemented Mathematics curriculum in the grades 4 - 6 Mathematics textbooks. The words recognise, visualise, name, describe, sort (classify), compare, draw, trace and locate are the verbs of doing the Mathematics of geometric figures (DBE, 2011b: 6, 14 - 16; Oxford, 2010: 999), and thus stipulate how the Mathematics will and should be done.

The specific content to show progression in terms of concepts, skills and values, is the stipulated "how", and reveals that the properties, relationships and orientations, positions and transformations of 2-D shapes have to be recognised, visualised, named, described, sorted, compared and drawn, traced and located (DBE, 2011b: 6, 14 - 16).

To recognise 2-D shapes is to know what they are from seeing, reading or learning about them because of prior or current encounter with them; to visualise 2-D shapes is to form pictures of them in the mind or to imagine them; to name 2-D shapes is to give names to them, call or identify them by specific names; to describe 2-D shapes is to say what they are exactly, or are similar to as a group and even as individual geometric figures; to sort (classify) 2-D shapes is to process or put them into groups, classes or divisions according to their characteristics, qualities or features, and to represent them is to give, show or depict an

example, expression or a symbol of them; to compare 2-D shapes is to examine them in order to see, show or even state how similar or different they are; to draw 2-D shapes is to make pictures of them with a pencil, pen or even a chalk; to locate 2-D shapes is to find the exact position of each of them or to draw them in a particular place and position (Oxford, 2010: 293, 395, 259, 444, 867, 972, 1239, 1266, 1407 & 1644).

Hence, doing the Mathematics of 2-D shapes in the intermediate phase grades 4 - 6 involves recognising, visualising, naming and / or identifying, describing, sorting or classifying, comparing, drawing or representing, tracing and locating the properties, relationships, orientations, positions and transformations of the 2-D shapes in detail and without fail in a variety of ways and forms.

2.2.3.3 Elements of the Mathematics curriculum: Conceptual and meaningful understanding

By definition, the Mathematics subject includes interrelated content knowledge, process skills and values that the general and specific foci, as well as aims, embody and seek to achieve, in order to fulfil the dictates of the content areas, and specific aims of the curriculum (DoE, 2002b: 4; 2002a: 14; DBE, 2011b: 4, 8 - 9). Mathematical content knowledge by itself consists of the topics, concepts, procedures and problem-solving skills (Dossey *et al*., 2002: 48). Hence, Mathematics teachers distinguish conceptual mathematical content knowledge and procedural mathematical content knowledge and understanding (Hiebert and Lindquist, 1990 as cited by Van de Walle, 2007: 28), which together with the execution of process skills, facilitates meaningful learning of Mathematics.

Conceptual content knowledge and understanding is “about the relationships or foundational ideas of a topic” (Van de Walle, 2013: 26). It constitutes the “why” in Mathematics, and involves the understanding of what makes the operations work or what something is (SMATE, 2007: 1; Dossey *et al*., 2002: 48). It enables learners to comprehend the ideas and concepts that they are studying and facilitates the finding of connections among those concepts as well as between the concepts and the procedures that are performed (SMATE, 2007: 1); “it is used to compare and contrast objects, as well as to form interrelationships between concepts and principles” (Dossey *et al*., 2002: 49), and “consists of logical relationships constructed internally in the mind, and exists as a part of a network of ideas in the mind” (Van de Walle, 2007: 30). Furthermore, learners exhibit conceptual content knowledge understanding “when they use concepts and their representations to discuss or classify mathematical objects”, and when they “recognise symbolic representations or interpret words as signifying operations and principles” (Dossey *et al*., 2002: 48).

Two features that are key to promote conceptual content knowledge understanding, are the ability of both teachers and learners to explicitly attend to the concepts, the content and the context that forces learners to struggle with important Mathematics in class during teaching lessons (Hiebert & Grouws, 2007: 383, 387). Attending to concepts is about making connections among mathematical facts, procedures, representations and ideas in an explicit, open, direct and public way (Hiebert & Grouws, 2007: 383, 384). Learners' struggle with important Mathematics is about the engagement of learners so that they expend some effort to make sense of the Mathematics, as opposed to simply being presented with the information to memorise (Hiebert & Grouws, 2007: 387, 388).

For the purpose of facilitating and developing meaningful understanding, Trafton *et al*. (2001: 259 - 263) describes six characteristics of the Mathematics textbooks, which are crucial to improving opportunities for learners to learn important Mathematics. According to them, it is critical that textbooks should be developed based on the six characteristics, which dictate that they (textbooks) should present Mathematics comprehensively and coherently, develop ideas in depth, promote making sense, engage learners and motivate learning (Trafton *et al*., 2001: 259 - 263). Abiding by these six characteristics will enable the textbooks to escape the two main strands of criticism: typically presenting mathematical ideas as facts to be memorised rather than as meaningful relationships (Reys *et al*., 2004: 64), and shallow Mathematics treatment and failure to stimulate learner interest or challenge learner thinking (Reys *et al*., 2004: 63).

2.2.3.4 Elements of the Mathematics curriculum: The textbooks

The Outcomes-based South African National Curriculum relied on a wide variety of learning support materials as tools, to interpret and give meaning to the content areas and the general and specific content foci (DoE, 2002a: 14; DoE, 2003a: 61). Hence, the wide variety of learning support materials authorised by the National and the Provincial Departments of Education to be used by teachers included textbooks, manipulatives or concrete materials, mathematical instruments, technology items, worksheets and mathematics journals (DoE, 2003a: 61). Within their role as designers and interpreters of learning programmes and materials, teachers were also encouraged to generate their own learning support materials, additional to the others named above, which were purchased and supplied by the department to schools (DoE, 2003a: 61; DoE, 2003b: 65).

However, the NCS Grades R - 12 emphasises textbooks as the primary learning support materials (DBE, 2010b). As tools of curriculum interpretation, textbooks under the NCS Grades R - 12 and CAPS will interpret and give meaning to the subject content areas and the

general and specific content foci, instead of learning outcomes and assessment standards respectively (2002a: 11 - 12, 14). Therefore the authors and publishers of the different textbooks have to base the content, context, rationale and processes of the Mathematics in their textbooks on the national curriculum policy (DoE, 2002a: 14), which according to Johansson (2005b: 12) is the "intended curriculum" for the Republic of South Africa. The textbooks, which are tools to give meaning to the national curriculum policy, represent the "potentially implemented curriculum", while the actual practice of enacting the curriculum in the classroom, as represented by strategies and activities is called the "implemented curriculum" (Johansson, 2005b: 12). The product or output of teaching and learning, as evidenced by the results of both formative and summative assessments of the learner, represents the "attained curriculum" (Johansson, 2005b: 12).

According to Robitaille and Travers (1992: 706), teachers of Mathematics in all countries rely heavily on textbooks in their day-to-day teaching. They decide what to teach, how to teach it, and what sorts of exercises to assign to their learners, largely on the basis of what is contained in the textbooks which have been authorised for their grade (Robitaille & Travers, 1992: 706). Reys *et al.* (2004: 61, 63) say the textbooks strongly influence what learners learn because they are used by teachers in three roles, viz. to determine the sequence of mathematical lessons through the year, to suggest the mathematical content of each lesson and to provide the teacher with the activities and instructional ideas for engaging learners during the lesson. The South African National Department of Basic Education concurs with Reys *et al.*, and declares that textbooks play a vital part in teaching and learning, and must be used by both teacher and learners to enhance their teaching and learning (DBE, 2010a: 6). Robitaille and Travers (1992: 706) and the DBE (2010a: 6) also explain that the primary roles of textbooks include being tools for curriculum interpretation and delivery, supporting assessment, assisting teachers with the pacing and weighting of content, as well as lesson and year planning, and being a resource for the learners. Thus, the contents of the textbook not only influences the learner, but also influences the teacher and the actual teaching activities taking place in the classroom on a daily basis. Hence, if the textbook is well written, resourced and outstanding, there is a possibility that it will be implemented as is and therefore will contribute toward the conceptual development and the educational achievement of the learners.

Whether the South African textbooks as tools interpret and give meaning to the Mathematics content areas and foci in the most accurate and comprehensive manner is under question in this study. After her study of a series of one commonly used Swedish school textbook, Johansson (2005b: 121) concludes that there is a minor agreement between the objectives

of Mathematics, explicitly stated in the national curriculum policy and the content of the textbooks. She further states that textbooks do not always and meticulously follow the guidelines of the intended curriculum (Johansson, 2005b: 123).

Mathematics textbooks play a very important role in teaching and learning of Mathematics, and must be used by both teachers and learners to enhance their teaching and learning (DBE, 2010a: 6). Accordingly, the primary role of textbooks includes being tools for curriculum interpretation and delivery, supporting assessment, assisting teachers with the pacing and weighting of content, as well as lesson and year planning, and being a resource for the learners (Robitaille & Travers, 1992: 706; DBE, 2010a: 6). However, Mathematics textbooks must not be assumed to be sufficient in their role. Instead, every Mathematics textbook in its entirety must first be evaluated to confirm that it fully and accurately interprets and gives meaning to all the relevant content areas and the general and specific content foci, and then be continually monitored through its numerous publications over time, for its continued fulfilment of this role.

2.2.3.5 Elements of the Mathematics curriculum: Readability of the textbooks

Both the “what” and the “how” are communicated through the medium of the English language of learning and teaching (LOLT) within the grades 4 - 6 textbooks. Hence, the learners for whom the textbooks are written and published must be able to read and make sense of them (Burns & Charleston, 1997: 291). Readability is the indication of the number of years of education that the learner needs to be able to understand the text easily on the first reading (www.online-utility.org). It is an attribute of the written text which theoretically makes text more or less difficult, and is commonly defined by factors such as vocabulary, sentence complexity, percentage of high frequency easy words, percentage of hard words, average number of words per sentence, average number of syllables per word, number of single syllable words or number of words with multiple syllables (Begeny & Green, 2014: 198).

Readability is a useful way to gauge whether a message is written at a suitable level for the intended learners (Burns & Charleston, 1997: 291). Hence, the readability of the textbook should be one of the first evaluations conducted by teachers or administrators in deciding whether to use a textbook or not, because a publication which has a readability level too high for the age level is not an appropriate choice, irrespective of what other favourable qualities the text possesses (Burns & Charleston, 1997: 291). It forms part of the ‘how’ as one of the elements of the intended curriculum, to inform, guide and prescribe the level of the LOLT for each grade and year level of the students for whom the textbook is meant.

According to Burns and Charleston (1997: 291), readability does not only affect text, but is a crucial factor in all written communication contexts, which includes written instructions to patients, notifications to employees about health and safety issues in industry and explanatory leaflets about rights to social security benefits. In all the listed contexts, much of the material produced has been found to be too difficult for the general population to understand.

For George Klare (cited by Steward, 2006: 10) readability involves three aspects: legibility, ease of reading or interesting to read (or interest value), and ease of understanding (the style of writing). However, of the three aspects of readability, only ease of understanding (style of writing) is quantifiable in terms of the immediately measurable properties of the text (Steward, 2006: 9).

To quantify readability, various readability measurements or mathematical formulae using different factors have been derived and used over the years. They include the Fry Graph, Dale-Chall, Lexile rankings, Spache, Coleman Liau Index, Flesch Kincaid Grade level, Flesch Reading Ease Index, Automated Readability Index (ARI), SMOG, Gunning Fog Readability Test (GFRT) and others (Steward, 2006: 10; Begeny & Green, 2014: 198 - 200). They were designed to predict ease of understanding as a function of quantitative features in the text in an attempt to facilitate the selection of optimal reading material (Steward, 2006: 10). Through the numerous formulas, readability is calculated and typically expressed as an estimated grade level to define the difficulty of the text based on the twelve year, grades K - 12 American school system (Begeny & Green, 2014: 198; Steward, 2006: 9), which is similar to the grades R - 12 South African school system. The estimated grade level, thus the difficulty level of the text, implies that an average learner and reader in the identified grade should be able to read or cope with the text without undue frustration (Begeny & Green, 2014: 198).

Each of the readability formulae measures different relative values within the same text, but all are dependent on the number of syllables or characters per word, allegedly determining the average complexity of the words used in the text and thus its semantic difficulty, and the number of words per sentence, measuring syntactic complexity (Steward, 2006: 9). The various formulae are the result of experimental trade-offs between the labour involved in the measurement of a text and the ultimate predictive power of the formula or its accuracy (Steward, 2006: 9). The formulae generally presume that longer words have more complex meanings, and hence that the average word length of a text is proportional to its relative semantic difficulty (Steward, 2006: 10).

Though the importance of readability is not under debate, the practicality of the current measurement tools is still controversial (Steward, 2006: 9) and the validity of the readability formulas is inconclusive, according to Begeny and Green (2014: 201). Furthermore, the grade levels estimated by the different readability formulas have consistently been found to be vastly different (Stokes, 1978: 21, 28; Begeny & Green, 2014: 202; Burns & Charleston, 1997:293); nevertheless, high correlations were found to exist between the formulas (Stokes, 1978: 28; Burns & Charleston, 1997: 293). According to Begeny & Green (2014: 198), some readability formulas are fairly good indicators of text difficulty for particular grade levels, with most being more accurate for higher ability learners. Specifically, the Spache, lexile, Dale-Chall and the Gunning Fog readability formulas have been identified as relatively reliable and valid measures of text difficulty level across grades 2 and 3, 3 and 4, grades 3 to 5 and grades 5 to 6, respectively (Begeny & Green, 2014: 210, 213). This implies that most readability formulas are inappropriate to use across all grade levels when the purpose is to consistently discriminate general difficulty level among reading materials (Begeny & Green, 2014: 210).

2.2.3.6 Elements of the Mathematics curriculum: English LOLT of the textbooks

In the intermediate phase grades 4 - 6, the language of learning and teaching is either Afrikaans or English (DBE, 2012d: 11). Furthermore, all languages, including the two, are offered at Home Language (HL) and First Additional Language (FAL) levels (DBE, 2012d: 11). In general, the majority of learners whose home language is not English are offering English as a First Additional Language (FAL) subject and are also using the same English as a language of learning and teaching (LOLT). According to the report on the Annual National Assessments (ANA) of 2012, the English LOLT in South Africa can either be the English HL or English as a FAL of the learner (DBE, 2012d: 11, 67 - 68). The difference between the English HL and FAL is the level at which the English language level is pitched (DBE, 2012d: 67), with Home Language being at a higher level than the First Additional Language.

Both English Home and First Additional Languages are part of the NCS Grade R - 12, from the foundation, intermediate, senior and further education and training phases. They are two different language subjects, allocated different teaching and learning (instructional) times throughout the different grades and phases. The subject combination in the NCS Grades R - 12 is such that no student can offer both in the same year, thus emphasising their similarity as language and difference in terms of level.

According to Burns and Charleston (1997: 296), all textbooks are evaluated for the age level of the English Home Language (HL) users and not the English First Additional Language

(FAL) users. Hence, any discrepancy with the evaluation (GFRT) will be far higher with the English FAL learners (Burns & Charleston, 1997: 296). Owing to more time allocated to HL in Grades R - 3 at school, the Grades 4 - 6 English FAL learners have had a limited exposure to English compared to their English HL fellow learners; hence, their English could be considered to be at least two years below that of their English HL fellow learners (DBE, 2011b: 6; Burns & Charleston, 1997: 296).

2.2.3.7 Elements of the Mathematics curriculum: Van Hiele Theory of Geometric Thought

The "what" and "how" as part of the elements of the intended curriculum are also informed, guided and prescribed by researched and world widely accepted theories of learning and teaching in Mathematics Education at the appropriate level, as reflected in research output documents and publications. The Van Hiele theory developed for the teaching and learning of geometry is currently part of the school curricula of the Netherlands and Russia and has had strong support and following in leading countries like the United States of America for some time now (Willemse, 2005: iv). For the South African context, Willemse (2005: iv, 131) recommended that all the geometry learning programmes and teaching units of the Revised National Curriculum Statement Grades R – 9 (Schools) be moulded on this theory.

The companion doctoral dissertations of a Dutch couple, Pierre Van Hiele and Dina Van Hiele-Geldof, postulated this theoretical learning model of geometric thought known as the Van Hiele Theory of Geometric Thought. According to the theory, learner progress through five different levels of thought in geometry, and learning experiences should be structured to promote conceptual growth and understanding through the levels (Clements, 2004: 60; Van Hiele, 2004: 62).

The Van Hiele theory is based on four assumptions (Clements, 2004: 60). Firstly, that geometry learning is a discontinuous process characterised by the five quantitatively different levels of thinking, namely, recognition or visualisation, analysis, ordering or abstraction or informal deduction, deduction and rigor, designated as developmental levels 0, 1, 2, 3 and 4, respectively (Van Hiele, 1986: 49; Clements, 2004: 60). Secondly, that the levels are sequential, invariant and hierarchical, and progress through them depends on teaching and learning and not on age, maturation or even school grade (Van Hiele, 1986: 50). Thus, learners cannot bypass the levels and achieve understanding, and the levels are reached by working through phases of teaching and learning (Van Hiele, 1986: 39; Clements, 2004: 60). Thirdly, concepts implicitly understood at one level become explicitly understood at the next higher level, and fourthly, each level has its own language, and teachers who are unaware of

the accompanying features of learners' learning can misinterpret their understanding of geometric ideas (Van Hiele, 1986: 40, 50; Clements, 2004: 60).

The five levels and their defining and corresponding knowledge and skills are spread through-out the school and university geometric education of a learner (Hoffer, 1981: 14), roughly apportioned for achievement at grades R - 3, 4 - 6, 7 - 9, 10 - 12 and university level geometry respectively in the South African education system, if appropriate and relevant teaching and learning developed in line with the levels takes place (Hoffer, 1981: 14; Van de Walle, 2007: 414).The five levels of geometric thought are described as follows:

- Level 0: Recognition or visualisation is the basic level of geometric thought wherein geometric concepts are viewed as total entities only, rather than as having components or attributes. As a result, 2-D shapes are recognised by their shape as a whole or physical appearance, only and not by their properties or constituent parts (Crowley, 1987: 2). Hence, a child recognises a rectangle by its form, which seems different from a square to him / her; he / she is able to reproduce the rectangle, square, rhombus, etc. without error, but does not recognise a parallelogram in the shape of a rhombus and the rhombus seems to him / her completely different (Van Hiele, 2004: 62).

- Level 1: Analysis is the first level wherein the analysis of the geometric concepts begins to take root. Through observation and experimentation, learners begin to discern the characteristics or properties of 2-D shapes and they are used to conceptualise classes of shapes (Clements, 2004: 60; Crowley, 1987: 2). Hence, 2-D shapes are now recognised as having parts and are recognised by their parts, and no longer by their physical appearance only (Crowley, 1987: 2). However, the properties are not yet ordered, thus a square is not necessarily identified as a rectangle (Van Hiele, 2004: 62).

- Level 2: Ordering / abstraction / informal deduction is the level wherein learners can establish the interrelationships of the properties of geometric figures, both within and amongst the 2-D shapes (Crowley, 1987: 3). The properties are now ordered and definitions of figures come into play; hence, a square is now recognised as a being a rectangle (Van Hiele, 2004: 62).

- Level 3: Deduction is the level wherein "the significance of deduction as a way of establishing geometric theory within an axiomatic system is understood" (Crowley, 1987: 4). Here at this level, "the interrelationships and role of undefined terms, axioms, postulates, definition, theorems and proof are seen" (Crowley, 1987: 4). Thinking is

concerned with the meaning of deduction, with the converse of a theorem, with axioms and with the necessary and sufficient conditions (Van Hiele, 2004: 62).

- Level 4: Rigor is the level at which "geometry is seen in the abstract" (Crowley, 1987: 4). The learner can, and is expected to, work in a variety of axiomatic systems that include the non-Euclidean geometries and comparing different systems (Crowley, 1987: 4).

Five sequential phases of learning, namely, inquiry or information, directed orientation, explication, free orientation and integration, are designed to enable learners to progress from a lower level to the following higher level of thought if teaching and learning (instruction) is developed in line with the phases (Van Hiele, 2004: 63; Crowley, 1987: 5). Together, the five sequential phases of learning form a period of learning, hence, four periods of learning will be needed to progress from level 0 to level 4. The five sequential phases of learning are described as follows (Van Hiele, 1986: 53 - 54; 176):

- Phase 1: Inquiry or Information takes place when the learner learns what the object of study is or recognises it (object of study) as the material related to the current object of study when presented to him / her by the teacher (Van Hiele, 1986: 177; 2004: 63). The teacher and the learner engage in conversation and activity about the object of study using the related material, questions and answers or re-directions, to enable the learner to make certain observations, discoveries, and gain vocabulary specific to the visual level (Crowley, 1987: 5). In the process, the teacher also learns what prior knowledge the learner brings to the object of study, and the learner learns what direction further study will take (Teppo, 1991: 212; Presmeg, 1991: 9; Crowley, 1987: 5).

- Phase 2: Directed Orientation takes place when the learner explores the field of inquiry by using the material introduced, through carefully guided and structured activities (Van Hiele, 2004: 63). The activities are meant to progressively expose the learner to the characteristic structures of the particular level, by eliciting responses from the learner (Teppo, 1991: 212; Presmeg, 1991: 9 & Crowley, 1987: 5).

- Phase 3: Explication takes place when the learners engage in discussion with one another and with the teacher (Crowley, 1987: 5). It is promoted by the learner expressing and exchanging his / her emerging views about the objects of study (Crowley, 1987: 5). The teacher assists and insists on the learner using accurate language appropriate to the level during discussions (Teppo, 1991: 212; Presmeg, 1991: 9 & Crowley, 1987: 5).

- Phase 4: Free Orientation happens when even if the student is still finding his/her way around the object of study, he / she engages in more open-ended activities that can be approached in different ways to arrive at several different types of solutions (Van Hiele, 1986: 177; Teppo, 1991: 212 – 213; Presmeg, 1991: 9 & Crowley, 1987: 5).

- Phase 5: Integration is where the teacher helps the learner to gain an overview of the fields of study, the methods at his / her disposal and to integrate the subject matter investigated. At this stage, rules may be composed and memorised for future use and nothing new is presented until the next level (Teppo, 1991: 213; Presmeg, 1991: 9). At the end of this phase, learners have attained a new level of thought. The new domain of thought replaces the old, and they are ready to repeat the five phases of learning at the next level (Crowley, 1987: 5)

According to Hoffer (1981: 11 - 13), there are five specific geometric skills that are connected with each of the five levels of geometric thought and development. These five geometric skills which underpin understanding in geometry are identified as visual, verbal, drawing, logical and application skills (Hoffer, 1981:11 - 13). The five skills are described as follows:

- Visual Skills are the ability to interpret figural information, manipulate and process (through rotation, reflection and translation) objects within one's mind (Davey & Holliday, 1992: 27) or the ability to understand the visual representations and spatial vocabulary used in geometric work, graphs, charts, and diagrams of all types (Bishop, 1983 cited byDavey & Holliday, 1992: 27).

- Verbal Skills are the communication skills, which are two-way, and constitute the rich, varied and precise vocabulary and language structural pattern (Davey & Holliday, 1992: 27).

- Drawing Skills are a form of communicating skills and can also be referred to as representing skills (Davey & Holliday, 1992: 28). They include the pencil and paper activities, as well as the constructing and modelling (Davey & Holliday, 1992: 28), and provide opportunities for learners to express their ideas in pictures and diagrams (Hoffer, 1981: 12).

- Logical Skills are the sense of justification or reasoning, language and analytical thinking; they form fundamental aspects of geometry at all levels and not just at the deductive level (Davey & Holliday, 1992: 28).

- Application or Applied Skills are the practical use of geometric knowledge or understanding in everyday life beyond the classroom in a variety of contexts (Davey & Holliday, 1992: 29).

In conclusion and summary of the elements of the curriculum, each textbook must comply with three requirements in order to fulfil its role of interpreting, giving expression and meaning to all the relevant general and specific foci. It must be readable for the learners at the appropriate level of the grade and year group; it must be congruent with researched and world widely accepted theories of learning and teaching in Mathematics Education at the appropriate level and grade (in this case the van Hiele Theory); it must be comprehensive and coherent, develop ideas in depth, promote sense making, engage learners and motivate learning in many ways, including conceptually and content-wise. (Trafton *et al*., 2001: 259 - 263).

2.2.4 The practice of curriculum

2.2.4.1 Orientation

The third question of curriculum, namely the practice of curriculum, concerns itself with the implementation of the curriculum, and is about teachers locating themselves within the seven elements of the curriculum and asking questions of "how to think and act or what to do" for and during implementation (Dillon, 2009: 348 - 349).

The questions of how to act or what to do concern the deciding and planning of curriculum, the implementing and experiencing of it, and the assessment and improvement of it by teachers (Dillon, 2009: 349). These questions of action regarding curriculum are deliberative questions taking the form of "what should be done?", while their answers in general take the form of decisions or resolutions to act (Dillon, 2009: 349).

The questions of how to think include the questions of curriculum research and inquiry, curriculum courses and degrees, curriculum theorizing, ideologies and perspectives and most importantly also include questions of how the teachers who are the everyday practitioners of curriculum, ought to think as they go about their curricular activities (Dillon, 2009: 349). They involve Taylors (p. ix) prescriptive / descriptive questions of "what should be taught?", "what should that result in?" and "what is believed necessary to produce that result?" (Dillon, 2009: 349). Hence, the question of "how to think" is not only a matter of how observers or researchers think about curriculum, but is mainly a matter of how those who practise curriculum ought to think as they act (Dillon, 2009: 349). The best characterisation of

this matter would be, "what are the questions to bear in mind as teachers do curriculum?" and / or "what are the questions that teachers are answering in action?" (Dillon, 2009: 349).

According to Tyler (1949, cited by Dillon, 2009: 351), a more systematic set of "four fundamental questions which must be answered in developing any curriculum and plan of teaching and learning" (of the practice of curriculum) is as follows:

(1) What educational purposes should the school seek to attain?
(2a) What educational experiences can be provided that are likely to attain these purposes?
(2b) How can learning experiences be selected which are likely to be useful in attaining these objectives?
(3a) How can these educational experiences be effectively organized?
(3b) How can learning experiences be organized for effective teaching and learning?
(4a) How can we determine whether these purposes are being attained?
(4b) How can the effectiveness of learning experiences be evaluated?

The set of four fundamental questions has a formulation with three schematic characteristics. In the first place, it identifies general elements or categories of curriculum about which questions must be asked and answered, viz. purposes, experiences, organisation and evaluation. Secondly, it formulates the general question about each necessary element and thirdly orders the categories and questions which are arranged in dynamic succession, so that one question leads into the other question which relates to a previous and subsequent one (Dillon, 2009: 351 - 352). Between the first question with the first feature of the first element for thought and action, namely educational purposes, and the final question with the final feature of the final element for thought and action, namely evaluation, are questions about the learning experiences that may be useful in achieving the previous question of purpose, and the effective organisation to give to these experiences (Dillon, 2009: 352).

2.2.4.2 Fundamental questions and the practice of the Mathematics curriculum

The practice and implementation of the Mathematics curriculum is developed and demonstrated by answering the four fundamental questions of Tyler (1949, cited by Dillon, 2009: 351). It mainly takes place through lesson planning and teaching-learning events and activities at classroom level. It involves defining the aims of schooling and the objectives of lessons, finding information about the content topics, concepts and skills, and deciding on suitable teaching-learning and assessment methods by teachers (Jacobs, 2011a: 33).

2.2.4.2.1 Educational purposes of schools

The educational purposes that the school should seek to attain in respect of Mathematics teaching and learning are answered by "why" or "to what end", the fifth element of the curriculum. They refer to the aims, objectives, aspirations, intents, ends in view, etc. According to Jacobs (2011b: 67), the basic educational and teaching purpose is to help learners to learn something. Hence, as a result of Mathematics teaching and learning, learners should act differently, thereby demonstrating change in their (learners') ability to perform, resulting from the Mathematics learning experiences undergone. The general Mathematics educational purposes include equipping learners with the Mathematics knowledge, skills and values necessary for self-fulfilment and meaningful participation in society as citizens of a free country; to provide access to higher education; to facilitate the transfer of learners from educational institutions to the workplace, and lastly to provide employers with an adequate profile of a learner's competencies (DBE, 2011b: 3).

Aims are broad, long-term educational intentions and statements used to explain the purpose of schooling, or what schooling should achieve. They normally take years to achieve; they set the general direction of teaching and learning and are consequently the first steps in deciding what to teach (Jacobs, 2011b: 67). Aims help to form the character of the learners and influence their philosophy of life; guide the teaching and learning events so that teachers are clear about the route they wish to follow and what they have in mind with certain learning content and activities Aims constantly remind teachers that their learners must be prepared for life by means of the selected content. The specific decisions relating to the aims are written as objectives (Jacobs, 2011b: 68).

The specific Mathematics educational purposes or aims of schooling are to develop the following in the learner: a critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations; confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics; an appreciation for the beauty and elegance of Mathematics; a spirit of curiosity and a love of Mathematics; recognition that Mathematics is a creative part of human activity; deep conceptual understandings in order to make sense of Mathematics; and the acquisition of specific knowledge and skills necessary for the application of Mathematics to physical, social and mathematical problems, the study of related subject matter and further study in Mathematics (DBE, 2011b: 4).

The specific Mathematics knowledge with regard to the research is that of the range, properties, relationships, orientations, positions, and transformations of 2-D shapes. The

specific Mathematics skills fall in five geometric categories, namely, visual, verbal, drawing, logical and application. Visual skills include recognising and visualising; verbal skills include naming or identifying and describing through communication; drawing includes representing, tracing, copying and locating; logical includes sorting or classifying and comparing, and application includes thinking, reasoning, decision-making, investigation and creating. The values include those of respect, equality, equity, unity, and diversity.

2.2.4.2.2 Educational experiences to be provided

The educational experiences the school can provide to the learners who are likely to attain the educational purposes named above in 2.2.4.2.1, are those that are general to teaching and learning and those that are specific to the Mathematics content knowledge and subject matter. Most educational experiences form part of a lesson which consists, amongst others, of the objectives of the lessons, content topics, suitable teaching-learning and assessment methods. General educational experiences include reading, writing, scaffolding, group work and co-operative learning, planning, representation, problem solving, decision making, and assessment. Specific Mathematics educational experiences for this research are described in operational terms like recognise, visualise, name, describe, sort, compare, draw and locate (Jacobs, 2011b: 68; DBE, 2011b: 6, 14 - 16).

A lesson is dynamic and consists of several essential elements, which include, objectives, rationale, teaching-learning methods, teaching-learning activities for the learners, media and LTSM and assessment procedure(s), which are also the essential building blocks of lessons (Nieuwoudt & Nieuwoudt, 2011: 323; Jacobs, 2011a: 52). These elements form a homogeneous mixture, cease to exist as separate elements and become a complete new whole once the lesson is implemented (Jacobs, 2011a: 52). Generally, teachers continually make decisions about these essential elements of lesson planning for each and every lesson that has to be conducted, and decisions include how to arrange and employ them in terms of pattern or manner of design and combination, in order for them to function effectively and sufficiently to facilitate the acquisition of the intended learning objectives (Nieuwoudt & Nieuwoudt, 2011: 322). Thus, even though these essential elements and building blocks of lessons are used over and over, they are not always joined in the same pattern or manner every time to form a functional unit (Nieuwoudt & Nieuwoudt, 2011: 323).

Objectives are narrow short-term intentional targets written for specific lessons and exercises, dealing with “what to teach” (Jacobs, 2011b: 67). They are unambiguous, clear descriptions and statements of what the learner should know, understand and be able to do at the end of the lesson or a period of teaching and learning, which the learner was unable to

do at the beginning (Jacobs, 2011b: 68; Nieuwoudt & Nieuwoudt, 2011: 323). Hence, teachers establish the objectives, teach towards the acquisition of the stated objectives and then assess the learners' attainment of the stated objectives (Jacobs, 2011b: 68). Consequently, objectives serve as guidelines for selecting, organising and presenting the learning content, and clear objectives will help the teacher to decide what content, how much content and the order such learning content should be presented in (Jacobs, 2011b: 68).

The functions of objectives are to determine learning activities and experiences, which are described in operational terms (e.g. list, name, compare, define) in objectives; to set the framework for the assessment process because teachers will not know whether the learners have achieved the targeted learning unless they know what they intended to teach and they assess that intention; to assist teachers to communicate with learners by sharing the objectives with their learners so that the learners will know what is expected of them and not have to guess what is important and what is not; and to determine the selection and integration of media, in terms of the nature of media to be used in the lesson, the manner of utilising the media and the moment at which the media can be used with the greatest effect (Jacobs, 2011b: 68 - 69).

When formulating lesson objectives, teachers have to be quite specific about what learners need to accomplish at the end of the lesson or series of lessons (Nieuwoudt & Nieuwoudt, 2011: 325). They have to formulate objectives at the micro-level of lessons in the classroom, and the more specific the formulation of an objective, the easier it will be to plan and implement a method to achieve it (objective). Irrespective of the topic, lesson objectives need to be specific and exclusive, each of them precisely specifying as far as possible, what learners need to achieve / be able to do after the lesson, thereby guiding the learner towards the aims. Furthermore, each lesson objective must also indicate how the targeted achievement could be recognised or measured. Hence, the formulation of a lesson objective must be set in behavioural terms, and the requirements are that it be measurable and set a standard and criterion for the achievement of the objective (Nieuwoudt & Nieuwoudt, 2011: 326).

2.2.4.2.3 Selection of learning experiences

The learning experiences which are likely to be useful in attaining the educational objectives or purposes should be selected by and from the historical and current experiences on individuals and groups, from educational research theories and findings, and from world wide accepted educational best practices. Hence, the knowledge, skills and values should be grounded and based on local contexts while being sensitive to global imperatives; be geared

towards social transformation; promote active and critical learning, high knowledge, skills and values; show progression of content and context from simple to complex within the grade and from a lower to a higher grade; be sensitive to human rights, inclusivity, environmental and social justice; value indigenous knowledge systems, and lastly be credible, of quality, widely varied and efficient (DBE, 2011b: 3).

For the specific purpose of the research, learning experiences must be selected to cover all of the four different cognitive levels of knowledge, routine procedure, complex procedures and problem solving; that they develop the essential Mathematics skills of and, the correct use of the language of Mathematics; application skills; learning to listen, communicate, think, reason logically and apply the mathematical knowledge gained; learning to investigate, analyse, represent and interpret information; learning to pose and solve problems and building an awareness of the important role that Mathematics plays in real life situations, including the personal development of the learner (DBE 2011b: 4). Furthermore, learning experiences should give learners the opportunity to identify 2-D shapes, describe the characteristics of 2-D shapes informally, develop their abilities to classify 2-D shapes and engage in inductive reasoning (DBE, 2011b: 14).

2.2.4.2.4 Effective organisation of educational experiences

For educational experiences to be effectively organised, they must form part of planning at the school and classroom levels and particularly the lesson plan. Educational experiences are regarded as being broader than just the teaching and learning experiences during a lesson, and include the lesson itself in all its different forms and purposes as well as the sports and recreational experiences.

Mathematics lessons are not all the same with regard to their nature, purpose, content knowledge, skills, values and attitudes, and therefore do not all follow the same pattern (Nieuwoudt & Nieuwoudt, 2011: 322, 324). However, they are at all times vehicles to help learners achieve expected destinations of competence, and thus the teacher uses every lesson as an instrument and a plan of action to enable learners to reach certain objectives in ways that are meaningful to them (Nieuwoudt & Nieuwoudt, 2011: 324). Hence, some lessons are directed at the learning of mathematical facts or rules, or the mastery of practical mathematical skills, while others promote conceptual mathematical understanding or the acquisition of mental skills (Nieuwoudt & Nieuwoudt, 2011: 322). Furthermore, some lessons have to be organised in a deductive way, where learners work from a generalisation, rule or definition towards specific examples or applications, while others need to be organised in an inductive way, where learners work from specific examples through a process of

investigation and reasoning to a generalisation, rule or definition (Sparks-Langer et al., 2004: 207 cited by Nieuwoudt & Nieuwoudt, 2011: 323).

One kind of lesson is not superior to the other and particular kinds of lessons are appropriate for particular kinds of outcomes (Nieuwoudt & Nieuwoudt, 2011: 323). Every lesson should be a purposeful and meaningful learning opportunity for every individual learner in class. Hence, planning demands much more than just merely the preparation of textbook content, it involves a complex and interrelated train of events and decisions about them. Lessons in Mathematics are not planned in isolation, but in units and modules as well as in relation to lessons in other subjects (Nieuwoudt & Nieuwoudt, 2011: 324).

2.2.4.2.5 Organisation of learning experiences for effective teaching-learning

For effective teaching and learning, the learning experiences must definitely be organised as part of a lesson plan which follow a specific teaching method according to the type of content knowledge, skills and values to be taught and learnt. The objectives of the specific lessons should be directed at specific action verbs that promote the different cognitive levels and order of thinking. Hence, mathematical learning experiences must also be guided by the four cognitive levels of knowledge, routine procedures, complex procedures and problem solving, in conjunction with the six levels of thinking in Bloom's Taxonomy, viz., remembering, understanding, applying, analysing, evaluating and creating (DBE, 2011b: 226; Jacobs, 2011b: 82 - 88).

The scope of the learning content knowledge and subject matter for each lesson should just be enough for learning to take place and the content should be organised under headings and sub-headings, topics and sub-topics. The concepts, skills and values to be learnt should be clearly stated and specific.

Teachers need to make informed choices about how each lesson can best be employed to the full benefit of the learners while fitting in with the broader context. For the development of effective lessons with learning experiences developed for effective teaching-learning, the following guidelines should be considered: limit the concepts and content to be dealt with to allow time for review, practice and feedback; new learning material has to be linked to what has been learnt previously; make sure that learners acquire the intended knowledge, skills and attitudes by checking frequently and re-teaching if learning has not taken place; all learners can learn, and never accept learners' failure as inevitable or unavoidable (Nieuwoudt & Nieuwoudt, 2011: 324).

2.2.4.2.6 Determination of the attainment of the purposes

To determine whether the educational purposes are being attained, an evaluation and level of attainment thereof should be assessed formally and informally, scholastically and ultimately at the societal level. Scholastically, the summative assessments at different phase exit levels of the NCS Grades R - 12 will be sufficient to determine whether a learner can be promoted to the next grade, exit the phase or the school system at the end of grade 12 (Nieuwoudt & Reyneke, 2011: 281).

Societal key indicators would have to be developed in society to check the presence and levels of self-fulfilment and meaningful participation in society, level of access to higher education; level of transfer of learners from educational institutions to the workplace and presence and level of provision of employers with a sufficient profile of a learner's competencies.

2.2.4.2.7 Evaluation of the effectiveness of learning experiences

The effectiveness and productiveness of learning experiences can be evaluated by and through formative assessment. Formative assessment is assessment for learning that involves frequent and continual use of both formal and informal classroom assessments in order to guide improvement, diagnose problems and enable learners to rectify mistakes; find out what learners already know; provide teachers with feedback on how their teaching is going; motivate learners, and add variety to learning experience and direction to teaching (Nieuwoudt & Reyneke, 2011: 282 - 284).

Three interrelated and interactive assessment processes of monitoring, assessment and reflection, need to be applied in a holistic manner to ensure that teaching-learning objectives are met and ultimately, the intended curriculum aims are achieved (Nieuwoudt & Nieuwoudt, 2011: 331 - 332). The three processes are linked, in the sense that each informs the other two and teachers are in the best position to ensure the achievement of the intended outcomes when they collaborate and cooperate with colleagues (Nieuwoudt & Nieuwoudt, 2011: 332).

Monitoring involves the measures that are taken during teaching-learning to judge progress in order to ensure that the teaching-learning activity is and remains on track, to check for understanding, and to collect information as a basis for decisions (Nieuwoudt & Nieuwoudt, 2011: 331). It (monitoring) is to supervise and watch whether plans are being implemented effectively; relate to the elements of assessment for learning and can be viewed as the guide to ensure the attainment of the intended objectives (Nieuwoudt & Nieuwoudt, 2011: 331).

Assessment is used to decide to which extent the general aims of the curriculum and specific aims of the subject as well as lesson objectives have been achieved (Nieuwoudt & Nieuwoudt, 2011: 332). It relates directly to the element of assessment of learning, and it is when the final outcomes of the whole teaching-learning process are weighed to judge the quality of the end product (Nieuwoudt & Nieuwoudt, 2011: 332). All planned and executed ideas and actions need to be assessed regularly at certain stages during the planning and implementation of lessons, as well as at the end of the planning and implementation phases (Nieuwoudt & Nieuwoudt, 2011: 332).

Reflection is the act of looking back at the teaching-learning process and its outcome, looking for links between the events (lessons and activities) in the process and elements of the outcome, rethinking decisions made during the process and reconsidering alternative options. It involves monitoring and assessment by asking critical questions about the process and its outcomes with the purpose of improving both. It is the key to ensuring that the intended objectives have been achieved (Nieuwoudt & Nieuwoudt, 2011: 332).

Objectives that guide learners towards developing the necessary knowledge and understanding of specified content are observable demonstrations of learning that occur at the end of a significant set of learning experiences and are used by the DBE to indicate knowledge, skills, attitudes and values (Jacobs, 2011a: 50 - 51). The knowledge, skills and values learners need to develop are applied to the specific content and thus divided into topics per subject per grade (Jacobs, 2011a: 51). Objectives deal with “what to teach” and determine the teaching method and assessment of learners (Jacobs, 2011a: 51 & 2011b: 67)

The rationale is the content, and also the purpose of the lesson which provides the motivation for and justification of the importance of the content (Nieuwoudt & Nieuwoudt, 2011: 323). The teaching-learning methods are the specific approaches that a teacher can use to transfer knowledge to learners, such as lecturing, questioning or discussing (Jacobs, 2011a: 52). They (teaching-learning methods) are important as a plan of action to give direction, and for each lesson aimed at teaching new content. Thus, a teacher must decide on the best teaching method suitable to guide learners from a state of ignorance to a clear understanding of the lesson content (Jacobs, 2011c: 156).

The teaching-learning activities include answers to the questions of how the prior knowledge of the learners will be activated, how learners will be engaged in the lesson, what support will be provided to learners and how the learning needs of individual learners will be met for purposes of differentiation (Nieuwoudt & Nieuwoudt, 2011: 323). The media and LTSM

stipulates what specific materials and resources are needed to teach the lesson, including visual materials, textbooks, workbooks, websites and any other specialised media and materials that will be utilised (Nieuwoudt & Nieuwoudt, 2011: 323).

The responsibility to choose a teaching method for a lesson rests on the specific Mathematics teacher, who is free to choose from amongst different methods as he / she sees fit, whether the methods are suggested in the textbook or designed by him / herself (Jacobs, 2011a: 52). The teacher chooses from two main groups of teaching methods, namely, the teacher-directed and learner-centred teaching methods, and all methods can be classified according to a continuum from being highly teacher-centred to being highly learner-centred. The closer the method is to the centre of the continuum, the more balanced it is in terms of its overall teacher-directedness or learner-centeredness. Teacher-directed methods include the telling method, scaffolding, demonstration and questioning, telling being the most teacher-directed and questioning being the least teacher-directed. They are based on reception learning where the content knowledge and subject-matter are presented to the learner to receive in its final form (Jacob, 2011c: 156). Learner-centred methods include discussion, cooperative learning, project method, role-play and experimentation, discussion being the least learner-centred and experimentation being the most learner-centred. They are related to discovery learning and based on the belief that reality must also be discovered by each individual learner on his / her own (Gawe et al., 2011: 186 - 187).

Assessment procedures are about the assessment decisions that must be aligned with the objectives and the rationale, and answer the questions about formative and summative assessments. Formative assessment includes answers to questions of how learners will be assessed, how feedback will be provided to the learners during lessons and what the opportunities for re-teaching are, while the summative assessment provides answers to whether the objectives of the lesson have been attained or not (Nieuwoudt & Nieuwoudt, 2011: 323).

The assessment of a learner consists of a task or series of tasks set in order to obtain information about a learner's competence (Jacobs, 2011a: 54). The tasks could be assessed in a variety of ways, using different assessment techniques throughout the learning process. Continuous assessment includes tests and examinations, but also relies on learners' projects, self and peer assessment and a range of other methods to measure the achievement of outcomes (DBE, 2011b: 222 - 227). Assessment is not a separate, secretive procedure that takes place at the end of a term or a year, but is a transparent, continuous process that is entrenched into the teaching-learning situation itself.

The forms and guidelines for assessment, including the assessment plan itself and the four cognitive levels used to guide all assessment tasks in the NCS Grades R - 12, include both teacher-directed and learner-centred assessment tasks, activities and descriptive skills to be demonstrated. Hence, a good balance of teacher-directed and learner-centred teaching is required and should be the norm in South African schools through the selected textbooks (DBE, 2011b: 222 – 227 & Gawe et al., 2011: 186).

2.3 MATHEMATICS TEXTBOOKS AND THE CURRICULUM

2.3.1 Orientation

Johansson (2005a: 43 - 44, 52, 54) describes the Mathematics textbooks in three different ways that may not be mutually exclusive, namely, as examples of secondary artefacts, as teachers and as instruments.

As secondary artefacts, Mathematics textbooks translate the Mathematics policy into pedagogy and are a link between the national guidelines of the intended curriculum and the implemented curriculum of the teaching-learning of Mathematics in schools (Johansson, 2006: 16, 24). They are human-made, with an author or a group of authors and a publisher, and are intended to be used for Mathematics education. The Mathematics textbooks serve at least two purposes, namely to offer and provide a well-made, carefully prepared authoritative pedagogical version of an area of knowledge and school Mathematics topics, and to gain a large market share for its publisher. They contribute to the field of Mathematics by preserving and transmitting knowledge and skills (Johansson, 2005a: 44 - 46).

As teachers, the Mathematics textbook scan contains only problems and exercises as one and only component part, or two separate parts with theory as one part and exercises and problems as the other part. Both kinds of contents of the Mathematics textbooks require the teacher to be a mediator of the text to the learner (Johansson, 2005a: 52). Other Mathematics textbooks have theoretical notes, remarks, clarifications and generalisations interspersed with problems, exercises and other assignments (Johansson, 2005a: 52).

As instruments, the Mathematics textbooks are for the use of both the teachers and learners to enact the intended curriculum for ultimate attainment. It is the teachers who decide on the choice of the specific Mathematics textbook (from the choice in the national catalogue) and how to use it. Hence, the teachers are the primary influence on which Mathematics textbooks learners use, and on how they (learners) use them. Johansson (2005a: 55) advocates that Mathematics textbooks should be mediated by teachers but should not replace teachers.

The Mathematics textbooks are often organised in such a way that they cover the topics that learners should encounter during a particular school year, thereby serving as some kind of agreement and support for uniformity within the school system (Johansson, 2006: 1). They have a prominent position because they are seen as a possibility to change and direct teaching for the best; facilitate the daily work of teachers; identify topics, order them in a way learners should explore them; attempt to specify how classroom lessons can be structured with suitable exercises and activities, and provide an interpretation of Mathematics to teachers, learners and their parents (Johansson, 2006: 1; DBE, 2011a: 6).

Teachers use Mathematics textbooks in different kinds of activities, namely, for teaching in order to lay down rules and conditions; for explaining the mathematical logical processes and going through worked examples, and for provision of exercises to practices (Johansson, 2005a: 56). They (teachers) deviate from Mathematics textbooks for different reasons, including if the suggested teaching method in a Mathematics textbook does not correspond to the way the teacher perceives that the subject should be taught; judging that exercises are inadequate; also if the textbook is inappropriate because the language is too difficult or the material is unfamiliar to the teacher and does not provide enough pedagogical guidance (Johansson, 2005a: 58).

2.3.2 Potentially implemented curriculum of Grades 4 - 6

The potentially implemented Mathematics curriculum concerning the space and shape Mathematics content knowledge and subject-matter around the conceptual understanding of 2-D shapes in grades 4 – 6, is mainly contained in the textbooks commissioned, written and marketed by the publishers. The DBE (2010a: 6) declared textbooks to be one of the most effective tools through which to interpret and deliver the intended curriculum, support assessment, ensure the intended curriculum content and assessment coverage, offer appropriate pacing and weighting of content, as well as lesson and year planning. Thus, the grades 4 - 6 Mathematics textbooks are expected to interpret and give meaning to the subject content areas and the general and specific content foci as specified in the Intermediate Phase Mathematics CAPS document (DoE, 2002a: 11 - 12, 14; DBE, 2010a: 6).

Furthermore, the grades 4 - 6 Mathematics textbooks should provide examples of problems, informal daily teaching and learning activities, suggestions for formal tasks, and present the concepts and content in an organised and systematic fashion (DBE, 2011a: 6). Reys *et al.* (2004: 61 & 63), declare that textbooks strongly influence what learners learn because they are used by teachers in three roles, namely, to determine the sequence of Mathematics lessons through the year, to suggest the mathematical content of each lesson and to provide

the teacher with the activities and teaching-learning ideas for engaging learners during the lesson. Hence, according to the DBE (2010a: 6) and Reys et al. (2004: 61 & 63), textbooks play a vital part in teaching and learning, and must be used by both teachers and learners to enhance teaching and learning.

The intended Mathematics curriculum in the intermediate phase grades 4 - 6 was written by people selected on a number of criteria, including that they are experienced in teaching the Mathematics subject; that their level of knowledge of the subject is deep and broad, and that they have an ability to write critically (DBE, 2011a: 12). Hence, it is fair and logical to assume that the authors of the textbooks who do the interpretation of the intended curriculum and ultimately write the potentially implemented curriculum or the textbooks, are more or less equally as experienced and knowledgeable in the subject Mathematics and the teaching thereof, and can also write creatively and critically.

The potentially implemented Mathematics curriculum (in the textbook) is equally as important as the intended Mathematics curriculum in the model because it ensures that the national education policy is interpreted and carried over to teachers and learners to produce the intended results. It is for this reason that the President of the Republic of South Africa in his 2011 State of the Nation address, made the call to his educational administration to "ensure that every child has a textbook on time" (DBE, 2011a: 18).

However, the learners cannot just be given any textbook on the market without considering its quality and degree of alignment with the intended curriculum. For this reason, the DBE puts a high premium on schools selecting and using high quality learner support material from the market. Subsequently the DBE introduced a new system of centralised national screening, selecting and provision of learner and teacher support material in 2011. The system focuses on two crucial aspects, namely ensuring that only high quality material is offered to schools and ensuring that all learners and teachers have the support material they need (DBE, 2011b: 18). For Mathematics, like all the other subjects, a specialist screening committee comprising subject matter experts, language experts, outstanding subject-area teachers and a facilitator will be put together, all "drawn from a mix of higher education institutions, non-governmental organisations and the Department of Basic Education" (DBE, 2011b: 18).

The national screening of Mathematics textbooks by the committee comprise two reviews (phases 1 and 2) of each textbook on a "blind" basis, i.e. author and publisher details removed from the submission. Phase 1 will be a filtering process to determine the shortlist of

titles. During this first phase, the national screening committee will check to see if the material is aligned to the intended curriculum (DBE, 2011a: 18). Phase 2 on the other hand will constitute a competitive rating exercise, aimed at identifying the best material from the short-list (DBE, 2011a: 18). On the basis of the results of Phase 2, a maximum of eight top-rated titles will be considered for final confirmation in the national catalogue of approved textbooks in 2012. Where fewer than eight titles are considered of appropriate quality, the number for final confirmation will be less than eight. Rigorous selection methods, based on international best practice, will be used to ensure that only the best quality material is offered to schools, who will select materials from this catalogue of nationally approved material (DBE, 2011a: 18).

Therefore, the contents of the textbook does not influence only the learner, but also the teacher and the actual teaching and learning activities taking place in the classroom on a daily basis. If the textbook is well written, resourced and outstanding, there is a possibility that it will be implemented as is and consequently contribute towards the conceptual development and the educational achievement of the learners.

2.3.3 Criteria for screening and evaluation

The 2012 invitation and terms of reference to submit grades 4 - 6 and grade 11 Learning and Teaching Support Material (LTSM) for evaluation and adoption in National Catalogue of the DBE, stipulate seven (7) criteria that will form the basis of the screening and evaluation process. These are curriculum content, content analysis, teaching and learning design, level, constitutional values, design quality and fitness for purpose (DBE, 2012a: 6 - 7). The submission parameters for the intermediate phase textbooks include that all textbooks submitted by publishers cover the three intermediate phase grades 4 - 6 in a particular language for Mathematics, and that all textbooks be accompanied by a teacher's guide in the same language as the textbook, all because the catalogue would serve for a period of three years (DBE, 2012a: 12).

The seven criteria form part of the "how" element of the intended Mathematics curriculum which must be interpreted and reflected as such in the potentially implemented Mathematics curriculum, the textbook, in terms of how it should do, be, have, in order to be regarded a good quality textbook that is fit for inclusion in the national catalogue.

The curriculum content criterion will be used to assess whether the textbook is aligned with the intended curriculum in terms of content, sequencing and progression of content knowledge (DBE, 2012a: 6). The Mathematics CAPS document specifies the scope of

learning and assessment, the curriculum content per subject per grade which is further divided into topics and sub-topics, as well as the time allocation and weighting of each topic (Jacobs, 2011a: 52; DBE, 2011b: 6 - 7). The content taught to learners must be orientated towards preparing them to live in a civilised community, and should aim at preparing them for the world of work (Jacobs, 2011a: 52). In agreement, Vakalisa and Gawe (2011: 146 - 147) declare that a good textbook is the best learning and teaching tool for the coverage and progression of content; it will demonstrate learning for progression, namely, the process of developing more advanced and complex knowledge and skills throughout the year, and from one grade to the next and should contain reliable information about the learning content selected and packed. Van Rooyen and le Riche van der Merwe (2011: 222) add that the textbook should provide new knowledge and build on what learners already know and understand; that headings of the different sections should stand out to enable users to construct a logical sequence of the content, and that they must provide explicitly stated outcomes in order to provide a guide as to how the reader should approach the content.

The content analysis will be done on sample sections of a text to determine whether the pedagogical approach or teaching method of each textbook and teacher's guide is based on sound understanding of how learning takes place (DBE, 2012a: 6). In support, Vakalisa and Gawe (2011: 147) declare that a good textbook is regarded as such because it is shaped by good pedagogy and designed to deliver the intended curriculum effectively.

Instructional design or teaching and learning method is about whether there are well formulated questions and activities that are clearly supporting the learning goals (DBE, 2012a: 6). The questions and activities should be strategically placed within and at the end of every section or chapter to encourage self-assessment and learner activity and should include questions and learning activities that encourage participative learning (Vakalisa & Gawe, 2011: 147).

The evaluation of the level of cognitive demand of the textbook is an investigation about whether the activities in the textbook make appropriate levels of cognitive demand on learners and use appropriate language for the grade (DBE, 2012a: 6), in light of the four cognitive levels used to guide all assessment tasks: where 25% should be knowledge, 45% routine procedures, 20% complex procedures and 10% problem solving (DBE, 2011b: 226).

According to Vakalisa and Gawe (2011: 146), the learning content selected and packaged in the textbook should be for the different cognitive levels of development of the specific grade and age. The revised Bloom's taxonomy classifies cognitive objectives to show how

textbooks, and thus teachers can organise the learning activities into six (6) levels, from the lower-order thinking skills, remembering and understanding, to the medium-order thinking skills, applying and analysing, to the higher-order thinking skills, evaluating and creating (Jacobs, 2011b: 79). In the continuum of cognitive thinking, remembering is the lowest and creating is the highest, and learners from an early age and grades must learn to successfully think and perform activities at all six (6) levels (Jacobs, 2011c: 81) through the selected textbook.

The South African Constitution, as well consequently the intended curriculum, is underpinned by, amongst others, principles and practices of human rights, inclusivity, a healthy environment and social justice; social transformation and valuing of indigenous knowledge systems. Therefore, the appreciation, conveyance and promotion of the constitutional values and attitudes espoused in these principles will be of primacy during the evaluation of the textbooks (DBE, 2012a: 7). The communication by the textbooks is a form of guarantee of the correct constitutional interpretation, but also ensures that the values are part of the everyday teaching-learning activities.

The design quality refers to a number of visual aspects of the textbook. These aspects include its attractive look, accessibility for and engagement of the learners (DBE, 2012a: 6 - 7); headings of the different sections standing out to enable user friendly reading without difficulty; designed pictures and diagrams that are clear and understandable; motivating, maintaining interest and encouraging learner participation; summaries at the end of a section or chapter which contain core content to help learners to assimilate the new content; having questions and activities at the end of a section or chapter to encourage self-assessment and learner activity; explicitly stated outcomes which provide guidance on how the learner should approach the content (van Rooyen & le Richie van der Merwe, 2011: 222).

A textbook as a tool for teaching and learning must demonstrate its fitness to help the learners learn. Hence, the fitness for purpose in the design of the textbook with regard to it meeting its intended purpose (DBE, 2012a: 7) refers to the textbooks being the real tools for interpreting and presenting the aims, scope / method, content and assessment for the grades 4 - 6 Mathematics. This includes that the language used should be clear, concise and at the appropriate level and experiences of the learners; textbooks should provide new knowledge and build on what learners already know and understand; the questions and activities should encourage critical thinking and encourage learners to seek answers from real-life situations as well and not from the textbook alone; the textbooks should present more than just one

view of an issue in a manner that learners apply and test the theories in the textbook (van Rooyen & le Richie van der Merwe, 2011: 222).

The guidelines for the terms of reference for the LTSM development and submission declare that the textbooks should meet the following requirements: focus on teaching the concepts and communicate the knowledge stated in the relevant CAPS document; be at an appropriate reading level for the intended grade; include a clear explanation of new terms and use them a few times in well constructed sentences to ensure that learners understand the context and use of the new vocabulary; include activities that have clear instructions, are easy to understand and do not require costly equipment; be organised in a way that provides a structured, well-paced and sequenced learning plan for the grade; be easy to navigate through the use of headings, subheadings, captions and labels for diagrams etc.; include the use of colour to support the clarity of representation as opposed to being decorative, while the font should be clear and readable (DBE, 2012a: 12 - 13).

The teacher's guides should include units, modules or chapters containing step-by-step guidelines on how to implement each activity. The requirements of the step-by-step guidelines are that they should be in sufficient detail to enable the teacher to implement the activity, but flexible, so that teachers can easily adjust the activity to suit their learners' needs. The teacher's guides should furthermore provide useful background knowledge to increase the teacher's understandings of key concepts; provide information on what can be assessed and how; provide teachers with a sample framework for assessment for the year and may finally include suggestions for extension and / or remedial activities (DBE, 2012a: 13).

General recommendations for the teacher's guide is that it must be written in user-friendly language; have an appropriate and user-friendly design and layout; encourage critical thinking and meta-cognitive strategies, and provide the teacher with sufficient learner-tasks to enable the learner to achieve the requirements of the CAPS. Learner-tasks should be appropriate for the level of the learners in terms of grade, language, knowledge, skills and concepts; reflect the pedagogical principles contained in the CAPS; show balance between individual, pair, group and class activities; reflect the values stated in the constitution, such as sensitivity to gender, race, culture and religion, and clearly explain the assessment within the activity / unit (DBE, 2012a: 13).

According to Vakalisa and Gawe (2011: 146) "textbooks make it possible for learners to learn from books as well as from the teacher". Furthermore, good textbooks are an important

component of the teaching-learning environment in schools and should use the appropriate language for the grade and age level of linguistic proficiency in order to be reader-friendly and encourage a culture of reading. They should provide an organised outline of the subject content that flows; be designed to deliver the intended Mathematics curriculum effectively and be the best learning and teaching tool for the coverage and progression of content knowledge and subject-matter, skills and values throughout the year and from one grade to the next (Vakalisa & Gawe, 2011: 147).

2.4 CURRICULUM IMPLEMENTATION

2.4.1 Introduction

Curricula are essential plans towards meeting the educational needs of realising the aims, intentions and expectations of education and training programmes (Nieuwoudt & Nieuwoudt, 2011: 309). Having plans designed does not guarantee success in achieving the expected aims of the NCS Grades R - 12. According to Nieuwoudt & Nieuwoudt (2011: 309 - 310), the success of the plans depends on whether teachers implement the plans as intended by aligning their daily teaching-learning activities in their classes in order to implement the intended curriculum. Teachers all over the world face the challenge of aligning daily teaching-learning activities to implement the intended curriculum; hence, research and experience suggest that there often is a gap between what is expected in the intended curriculum and the results of what is implemented in the classroom (Nieuwoudt & Nieuwoudt, 2011: 310). Thus, the attained curriculum is not the intended curriculum.

2.4.2 Orientation

According to Stein et al. (2007: 322), there are transformation phases in the implementation sequence of the teachers. The first transformation phase occurs when teachers transform the intended curriculum into a plan of action to be implemented in their classes (as the implemented curriculum). This transformation depends on, and is determined, by three factors, namely, the teachers' decision-making based on their knowledge, beliefs and experience; teachers' implementation acts which vary from following the design to interpreting it and putting it into action; and support for implementation in the form of textbooks, workbooks and LTSM in general. (Stein et al., 2007: 322). The plan of action to be implemented represents the teachers' intentions and strategies to facilitate the realisation of the specific aims of the Mathematics taught in their classes. It does not represent what actually happens or what is enacted / implemented in the classroom (Nieuwoudt & Nieuwoudt, 2011: 311).

It is only when executing the plan of action and their planned teaching and learning programmes, that teachers transform their plan of action into the actual operations and activities, which then constitute the implemented or enacted curriculum (Nieuwoudt & Nieuwoudt, 2011: 311). According to Nieuwoudt and Nieuwoudt (2011: 311), the success of the implemented curriculum depends to a large extent on a number of factors, including how closely learners can demonstrate the achievement of the aims and objectives of the original designers and teachers; the quality of the plan of action compared to the expectations of the design, as well as the congruence (sameness) between the plan of action to be implemented and the implemented curriculum (Nieuwoudt & Nieuwoudt, 2011: 311).

2.4.3 Teacher as curriculum implementer

The successful implementation of the intended curriculum requires teachers to be competent in applying a participative approach with practical understanding in their classes; that they (teachers) have relevant mathematical knowledge and insight, and that they also demonstrate practical decision-making and planning skills to implement effective teaching-learning events like work schedules and lessons in order to achieve what is expected of learners to achieve (Nieuwoudt & Nieuwoudt, 2011: 312). The factors that influence teachers' decisions before they actually start planning lessons are informed by knowledge of various aspects that can directly influence their planning (Stein et al., 2007: 353). The focus is on the teachers' knowledge of aims and objectives, learner characteristics, content, teaching methods and tacit knowledge (Boric, 2000: 111 - 113 as cited by Nieuwoudt & Nieuwoudt, 2011: 312).

With regard to the specific aims of Mathematics, the teacher must decide in advance, for each lesson, precisely what objectives need to be achieved in order to give structure to lesson planning, and tie the planning to societal values and expectations (Nieuwoudt & Nieuwoudt, 2011: 312). It is important that the teacher should formulate the intended lesson objectives in clear, accurate and feasible terms (Sparks-Langer et al., 2004: 51 - 52 as cited by Nieuwoudt & Nieuwoudt, 2011: 312).

Learner characteristics include their needs, abilities, achievements, personalities, home backgrounds and many others. If teachers do not understand these, it is highly unlikely that they will be able to present lessons enabling learners to achieve the specific objectives of these lessons (Nieuwoudt & Nieuwoudt, 2011: 313). Thus, more than any other factor, learner characteristics should feature prominently during teachers' planning (Nieuwoudt & Nieuwoudt, 2011: 313).

“The learning content first needs to be analysed and then organised in such a way that learners can make sense of it and can link it to their prior knowledge and experience” (Nieuwoudt & Nieuwoudt, 2011: 314). Hence, if a teacher lacks proper understanding of the content, it is highly unlikely that he / she will be able to plan a lesson during which the learners will learn the content in a meaningful way. It is crucial that teachers know the subjects that they have to teach well, in order not to have difficulty in planning effective lessons. They should be able to analyse and organise the learning content, to relate parts, to the whole, and know how content is prioritised, how transitions are made between topics, and which themes are major or minor (Nieuwoudt & Nieuwoudt, 2011: 314).

During the planning stages of lessons, teachers need to consider the appropriate teaching methods as well as LTSM that can be used to create meaningful learning opportunities to satisfy their learners’ needs (Nieuwoudt & Nieuwoudt, 2011: 314). The teaching methods and LTSM are the teachers’ tools and form a rich repertoire from which they should be able to select and apply the correct method to help learners understand the work (Nieuwoudt & Nieuwoudt, 2011: 314). They should also consider media, make decisions about textbooks, workbooks, apparatus, software, etc., and must also update and extend their knowledge on an ongoing basis, by either studying further or reading more about factors that make some teachers more successful than others (Nieuwoudt & Nieuwoudt, 2011: 315).

Over an extended period time, individual teachers become aware of what works for them, and thus develop a body of personal or tacit knowledge which comes with experience and not through reading. If teachers keep a record of their experiences and continuously add to and adapt their tacit knowledge, the growing body of tacit knowledge will guide them in their lesson planning and implementation. Tacit knowledge is never complete, but instead keeps changing and growing and is an integral part of a teacher’s lifelong learning (Nieuwoudt & Nieuwoudt, 2011: 315). Hence, teachers must continually be vigilant in acquiring the correct and relevant tacit knowledge that will enhance their effectiveness and efficiency in the classroom.

2.4.4 Support for implementation

To successfully implement the intended curriculum, teachers need the necessary and sufficient material, professional pre-service and in-service teacher training, as well as contextual support from all stakeholders in education (Nieuwoudt & Nieuwoudt, 2011: 317). Material support is the means to implement the curriculum and includes sufficient LTSM in the form of textbook, workbooks and teachers’ guides (Nieuwoudt & Nieuwoudt, 2011: 317 - 8; DBE, 2009: 51).

Teachers as curriculum implementers cannot be expected to perform their task flawlessly without support. Their professional teacher training support includes training to empower them to understand and execute new methodologies and changed practices, as well as the use of new materials (Nieuwoudt & Nieuwoudt, 2011: 318). Their levels of professional competence should receive attention, together with their content knowledge, skills, values, and views about the curriculum (Nieuwoudt & Nieuwoudt, 2011: 318).

The critical contextual support for the successful curriculum implementation includes the school management teams (SMT), the subject advisory and other specialist services, and the surrounding community. The school management teams, which include the principal, deputy principal and the head of department, provide leadership at the local level to create an environment conducive for the teaching-learning activities to take place (Nieuwoudt & Nieuwoudt, 2011: 319). The Mathematics subject advisory services supported by the Mathematics non-governmental organisations provide the contextualised Mathematics support for the Mathematics teachers in the content subject knowledge, skills and values that may include the choice and use of textbooks. The supportive school communities include the teacher organisations / unions, and the immediate school communities which must collaborate with the individual school teachers, Mathematics specialists and the professional organisations (Nieuwoudt & Nieuwoudt, 2011: 319).

2.4.5 Design principles and organising tools

Planning for teaching in the Mathematics classroom starts well before the actual presentation of the specific lesson in the classroom (Nieuwoudt & Nieuwoudt, 2011: 319). Thus, to achieve the objectives, a teacher needs to design and develop the specific lessons, and choose appropriate and relevant learning and teaching support material (LTSM) for the content subject matter and learners, while being sensitive and responsive to the learners' backgrounds. The chosen textbook(s), primary and subsidiary, need to provide guidelines to teachers in accordance with the national curriculum documents, so that the teachers in schools are not left to their own means. During the lesson design and development, schools and teachers have to apply the two important design principles of integration and progression (Nieuwoudt & Nieuwoudt, 2011: 319). Two additional and useful organising tools operating within the principles of integration and progression, namely the concept maps and flow charts, are available to teachers (Nieuwoudt & Nieuwoudt, 2011: 319).

The principle of integration requires learners to use their knowledge and skills from other subjects or from different parts of the same subject to carry out tasks and activities (DoE, 2002a: 13). A concept map, also referred to as a spider diagram, is a way to depict how a

central concept is formed or even explained by linking main ideas in a logical way (Sparks-Langer et al., 2004: 75, cited by Nieuwoudt & Nieuwoudt, 2011: 320). The resulting diagram represents important elements and relationships in a mathematic curriculum content topic and makes it easier to organise the mathematical content involved in a logical way and to decide on the teaching-learning activities (Nieuwoudt & Nieuwoudt, 2011: 321). According to Nieuwoudt and Nieuwoudt (2011: 320), the principle of integration and the concept map are used to link different subjects and to teach and learn more core concepts in Mathematics. More importantly, at least one full lesson is needed to teach a core concept by way of a concept map and the teachers can conduct this lesson using the information offered by learners during a class discussion, or the learners individually or in groups can design one (Nieuwoudt & Nieuwoudt, 2011: 320).

The principle of progression enables learners to gradually develop more complex, deeper and broader knowledge, skills, and understanding in each grade (DoE, 2002a: 13). A flow chart is an effective way of showing how a process of development of a concept, or the unfolding of a lesson, progresses in time (Nieuwoudt & Nieuwoudt, 2011: 322). Arrows linking the boxes in a flow chart diagram give a visual image of how elaboration of concepts and new ideas evolve in terms of how the central concept grows and becomes more complex in time, or even how events proceed in a lesson (Nieuwoudt & Nieuwoudt, 2011: 322). A flow chart enables teachers to trace the developmental moments of a concept or process, which can assist in organising and planning lessons in a coherent and interrelated manner and the formation of gaps in learners' conceptual development can be prevented and overcome by means of the flow chart (Nieuwoudt & Nieuwoudt, 2011: 322).

2.5 CONCLUSION

Textbooks are a predominant source in many Mathematics classrooms and have a unique status. They often determine what school Mathematics is and also what Mathematics is for both teachers and students (Valverde et al., 2002, cited by Johansson, 2005a: 60).

The seven (7) criteria will ensure that the screening of the grades 4 - 6 Mathematics textbooks for inclusion in the catalogue is objective, unique for Mathematics, and that ultimately, the intended grades 4 - 6 Mathematics curriculum of the Republic of South Africa, as expressed by the National Curriculum Statement Grades R – 12, is actually the potentially implemented curriculum. If and when the intended curriculum of the Republic of South Africa is actually the potentially implemented curriculum, the problems of Mathematics education will exclude the quality of the textbooks, and focus on the implemented curriculum. For now,

however, the problems of Mathematics education in schools may not exclude the potentially implemented curriculum, namely the textbooks.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

The study explores the appropriateness of the readability and the geometric teaching-learning activities, practices and general exposition pertaining to the 2-D shape topics, concepts and skills in a series of five different grades 4 - 6 Mathematics textbooks.

The aim of the study is four-fold, as follows in terms of objectives:

- Firstly, to determine whether the readability of each of the five grades 4 - 6 textbooks is at the acceptable English language level for the age and grade of the learners.
- Secondly, to determine whether the teaching-learning activities in each textbook are compliant with the topics, concepts and skills prescribed by the grades 4 - 6 shape and space (geometry) specification of content (phase overview) in the CAPS document.
- Thirdly, to determine whether for purposes of progression, the teaching-learning activities in grades 4 and 6 are compliant from grades 3 and to grade 7 respectively.
- Fourthly, to determine whether the level 0 and 1 descriptors of the Van Hiele Theory of Geometric Thought described in the literature as promoting the progression of geometry understanding are complied with in the textbooks.

The intention of the second, third and fourth objectives is to determine whether there is congruence between the actual contents of the textbooks that are deemed suitable and appropriate by the DBE and both the CAPS Mathematics policy document and established research findings.

3.2 RESEACH PARADIGM

The assumption of the researcher for this study about Mathematics teaching, learning and conceptual understanding was of a constructivist or socio-constructivist paradigm. This implies a learner-centred Mathematics teaching and learning of the topics, concepts and skills of 2-D shapes in the grades 4 - 6 textbooks, aimed at the learner's personal construction of own mathematical knowledge (Nieuwoudt, 2006: 15; Vakalisa, 2011: 5; Jacobs, 2011a: 41). The learner is actively involved in the building of concepts, conceptual understanding and skills, by comparing new and prior knowledge and building on previously constructed knowledge. Further assumption is that the textbooks strongly promote verbal and written communication for the learners to verbalise or demonstrate their conceptual thinking process, but also to receive feedback from the teacher and fellow learners.

3.3 METHODOLOGICAL PERSPECTIVE

This study used the qualitative research design, where-in the ordinary English language as well as the topics, concepts and skills of 2-D shapes in the textbooks were analysed to see if they are compliant with the Gunning Fog Readability Indices (GFRIs), the intended curriculum contained in the grades 4 - 6 CAPS document and the first two levels of the Van Hiele Theory of Geometric Thought. Thus, a pragmatic worldview, with both a document and conceptual analytical study (Nieuwenhuis, 2010: 71) research methodology as strategy of inquiry was implemented to study the state and level of language and conceptual compliance in the five grades 4 - 6 Mathematics textbooks identified for the evaluation. The textbooks exist as secondary documents, hence, the design classification for this study, is of several secondary textual sources of data (Mouton, 2001: 144, 175; McMillan 2000: 263).

The specific research design was chosen mainly because the five series of grades 4 - 6 Mathematics textbooks in the catalogue of the DBE consist of secondary textual data, are engaged in several mathematical concepts (including the concept of 2-D shapes), and are by their nature and use as the primary learning support documents, involved in contributing towards the development of conceptual understanding of the concepts therein. The conceptual analysis will assist to bring about general conceptual clarity, and specifically identify and clarify conceptual categories, explicate theoretical linkages and reveal conceptual implications of different viewpoints (Mouton, 2001: 175).

The primary characteristic of this qualitative research is that of the researcher as the key instrument of collecting data (Creswell, 2009: 175) through examining the textbook documents, using the GFRT, the CAPS-based and Van Hiele-based instruments. The CAPS-based and the Van Hiele-based instruments are both developed by the researcher with the grades 4 - 6 CAPS document and the van Hiele level 0 and 1 descriptors and sample learner responses as the basis. The common skills of both the Mathematics curriculum and Van Hiele Theory of Geometric Thought are organised around teaching-learning topics, concepts and skills of the CAPS and the level descriptors respectively.

3.4 CONTEXT OF THE STUDY

There is no location of site or social network selection for this study of the grade 4 - 6 Mathematics textbooks. This means that no primary or secondary schools, adult education and training centres or any other institutions of learning, or even teachers, will be approached to participate in the research.

3.5 SAMPLE STUDY POPULATION AND SELECTION

Five of only eight series of grades 4 - 6 Mathematics (English LOLT) textbooks approved and included in the national catalogue of intermediate phase textbooks were evaluated. Thus, a total of fifteen textbooks, five textbooks for each of the three grades 4 - 6, and three textbooks per series, produced by three publishers, were evaluated. The five series of textbooks were simply labelled series 1 - 5, abbreviated S 1, S 2, S 3, S 4 and S 5, where S equals series, and will remain anonymous for the whole study in terms of their titles, publishers, authors and ISBN numbers. The five series of textbooks were the only ones in use at the English LOLT primary schools in the greater Potchefstroom area which includes Potchefstroom town, Ikageng, Mohadin and Promosa. In fact, the textbooks were sourced for evaluation from the schools alone since they were not available yet at the book stores and the University library when the evaluation began early in the year.

In line with the title of the dissertation, namely, the contribution of the grades 4 - 6 Mathematics textbooks towards the development of conceptual understanding of 2-D shapes, the concentration of the evaluation fell on the geometry sections and specifically those dealing with 2-D shape. All four of the five series of textbooks named the sections inside either units or topics, therefore only the units and / or topics of the textbooks dealing with 2-D shapes were evaluated according to the measuring instruments, and specifically the units and / or topics titled properties of 2-D shapes, geometric patterns, symmetry and transformations for CAPS compliance and progression in the grade 4 - 6 textbooks.

3.6 DATA COLLECTION STRATEGIES, INSTRUMENTS AND PROCEDURES

Three instruments were used to perform the document and conceptual analysis of the textbooks and gather data for this study, in line with Appendices A - I. The instruments are the readability, the CAPS-based and the Van Hiele-based measuring instruments. In addition, Tables 4.1 – 4.11 are the important abbreviated versions of Appendices A – I, located within the different relevant sections of Chapter 4.

3.6.1 The readability measuring instrument

3.6.1.1 Use of the readability instrument

The readability of each textbook per grade and per series was evaluated twice by means of the Gunning Fog Readability Test (GFRT) to obtain two Gunning Fog Readability Indices (GFRIs) of each textbook. The tests were done to establish whether the number of years of formal education that a learner needs to be able to understand the text easily on the first reading is consistently adhered to by each textbook individually and by the series of textbooks for each grade (see 2.2.3.5).

The GFRI reading difficulty level and its appropriateness for learners in each of the three grades was calculated by taking relevant full continuous text passages of about 100 words from each textbook to process them with the Gunning Fog Readability Test online software tool. The two passages were chosen at different parts of the units or topics concerning 2-D shapes in each textbook and comprised specific teaching and learning activities or groups thereof, as well as sections of the text that explain the content knowledge and skills of 2-D shapes in the textbook. The number of words in the actual passages used to calculate the GFRIs varied from 47 to 133 words.

Each of the two passages was entered into the online window of the software tool of the online readability calculator website for testing document readability, before pressing the "process text" button to have the index calculated by the software tool. The specific website address is reflected on the actual readability printout results obtained and availed as Appendix J. Besides the GFRI results, the online calculator also calculated and produced the Coleman Liau index, Flesh Ki ncaid Grade level, Automated Readability Index, SMOG and the Flesh Reading ease (see Appendix J).

The GFRI is a discreet decimal fraction rounded to two decimal places and strictly indicates the expected or determined readability of a specific grade alone. The readability results of the two passages from each textbook in the form of two indices are reflected in Tables 4.1 - 4.3 (see 4.3.1, 4.3.2, 4.3.3) for record purposes, but also for comparison among all grade 4, 5 and 6 textbooks of the different series.

3.6.1.2 Motivation for the GFRT for readability

The DBE's fourth criterion for the screening and evaluation process of the textbooks, the guidelines of the terms of reference for the development and submission of LTSM, and the general points for the teacher's guide, all emphasise the use of the correct level of the English language in writing (see 2.3.3; Appendix K). Specifically the expressions "appropriate reading level for the intended grade", "written in a user-friendly language" and "appropriate for the level of learners" are all evidence for the need of the GFRI or similar measuring instrument to establish the language communication level of the textbooks (see 2.3.3; Appendix K).

The DBE has not indicated the use of any of the available tools named in 3.6.1.1 above to determine the appropriateness of the level of the language of the textbooks. Barring human error, fatigue and slower pace, a trained and qualified English language level specialist may be able to gauge the general language level by reading through the textbooks. However, a

Mathematics specialist will not be appropriately qualified to do the same. Hence, the GFRT is better suited for use to measure the readability of every textbook and provide the record of the exact level determined for reference and comparison at a later stage. Any improvement in establishing the exact English language reading level carries the hope for credibility, quality and trustworthiness of the readability results.

3.6.2 The CAPS-based measuring instrument

3.6.2.1 Use of the CAPS-based instrument

The CAPS-based measuring instrument was used to measure the level of CAPS compliance in the grades 4 - 6 Mathematics textbooks. It was divided into five specific and different instruments for measuring compliance, titled Appendix B - F. Appendices C, D and E were used to measure CAPS compliance in the grades 4, 5 and 6 textbooks respectively; Appendix B was used to measure CAPS progression compliance from grade 3 in the grade 4 textbooks and Appendix F was used to measure CAPS progression compliance to grade 7 in the grade 6 textbook.

Therefore, the grades 4 and 6 textbooks were evaluated twice, firstly for the progression of the topics, concepts and skills relating to 2-D shapes in each respective grades, but also from the previous grade 3 in the case of grade 4 and to the next grade 7 in the case of grade 6. However, the grade 5 textbooks were only evaluated for their compliance with CAPS at the grade 5 level and not for progression from grade 4 to 5 or even for progression from grade 5 to 6. The evaluation of progression for the grades 4 and 6 textbooks is particularly important since the two grades are the beginning and ending of the intermediate phase grades which are the focus of this study. Appendices B, C, D, E and F serve two purposes, first as the measuring instruments and secondly as the presentation of corresponding results in score form obtained from the evaluations of the fifteen grades 4 - 6 textbooks.

3.6.2.2 Motivation for the CAPS-based measuring instrument

The DBE's criterion of curriculum content unequivocally dictates that the grades 4 - 6 textbooks be assessed for compliance with the relevant grades 4 - 6 Mathematics CAPS document in terms of the topics, concepts, skills and values (see 2.3.3; Appendix K). This is also based on the proclamation of the DBE that textbooks are one of the most effective tools to interpret and deliver the intended curriculum in the CAPS policy document; that they play an indispensable part in teaching and learning, and that they must therefore be used by both teachers and learners to enhance the teaching and learning (see 2.3.2). Hence, systematic, proper and specific textual analysis and evaluation of the topics, concepts and skills that

support the teaching-learning objectives for the grades 4 - 6 Mathematics conceptual understanding of 2-D shapes should reveal the level of compliance.

3.6.2.3 Description of the CAPS-based measuring instrument: The five geometric skills

Appendices B – Fare tables which serve the CAPS-based measuring instruments. Each of the Appendices B - F evaluates the five geometrical skills, namely, visual skills, verbal and / or written skills, drawing skills, logical skills and applied skills (see 2.2.3.7), all underpinned by specific descriptive teaching-learning activities that formed evaluating principles and aspects of each textbook. The teaching-learning activities represent the topics, concepts and skills related to 2-D shapes in the grades 4 - 6 Mathematics CAPS, which must form the contents of the textbooks as part of the textbooks' interpretation and implementation of the intended curriculum (see 2.2.2.2; 2.2.3.2).

The visual skills form section A of each of the five CAPS-based measuring instruments. They comprise the ability to recognise, visualise and identify by sight all the relevant teaching-learning aspects in the exposition, explanations, exercises and activities in the textbooks (see Appendices B - F). The two main headings of teaching-learning activities appropriate and relevant to learners are that learners recognise 2-D shapes, their angles and symmetry and that they recognise different 2-D shapes in different settings and environments (see Appendices B - F).

The recognition aspect of the visual skills involves two categories. The first category is of recognition of progression from the previous grade, and thus revision in a sense, because learners are familiar with and have a picture of the topics, concepts and skills their mind. The second category is of recognition of new topics, concepts and skills that exist, that are related or unrelated with the previous, but must be visualised and learnt. In either case, recognition aspects involved must be visibly depicted in drawings and / or written format, or presented as revision or new information and content, including as teaching-learning activities and progression of knowledge in the learner book. In the measuring instruments, the visual skills are more than just the ability to interpret figural information and to understand the visual representation and spatial vocabulary. They instead are achieved through the textbook communicating effectively using visual, symbolic and language skills in various modes (see 2.2.2.2). They also provide new knowledge and build on previous knowledge (see 2.3.3).

The verbal and / or written skills form section B of each of the five CAPS-based measuring instruments, consist of describing, naming and identifying (verbally and / or through writing)

and are the communication skills applicable to only the exercises and activities in the textbooks (see Appendices B - F). To comply with the CAPS, the teaching-learning activities represented by exercises, activities and questions in the grades 4 - 6 Mathematics textbooks were expected to ask learners to describe, identify and name 2-D shapes, patterns, angles, lines of symmetry verbally and / or through writing, according to their characteristics and properties in different specified ways (see 2.2.3.2; Appendices B - F).

The drawing skills form section C of each of the five CAPS-based measuring instruments. They consist of drawing, tracing, copying, constructing, putting together, building, tessellating, transforming and are also applicable to exercises and activities only in the textbooks (see Appendices B - F). They are the pencil and paper activities that enable the learners to express their ideas in pictures and diagrams (see 2.2.3.7). To comply with the CAPS, the teaching-learning activities represented by exercises, activities and questions in the grades 4 - 6 Mathematics textbooks were expected to ask learners to draw, construct, copy, trace, put together, tessellate and transform 2-D shapes, patterns, angles, line(s) of symmetry, etc., according to their characteristics and properties in different specified ways (see 2.2.3.2; Appendices B - F).

The logical skills form section D of each of the CAPS-based measuring instruments. They consist of sorting and comparing; are also applicable to exercises and activities only, and provide a sense of justification and reasoning (see 2.2.3.7). To comply with the CAPS, the teaching-learning activities represented by exercises, activities and questions in the grades 4 - 6 Mathematics textbooks were expected to ask learners to sort, compare 2-D shapes, patterns, angles, lines of symmetry, etc. according to their characteristics and properties in different specified ways (see 2.2.3.2; Appendices B - F).

The applied skills form section E of each of the five CAPS-based measuring instruments. They consist of thinking, reasoning, problem solving, decision making, investigation, creation, making and producing, are also applicable to exercises and activities only, and provide the practical use of the geometric knowledge and understanding (see 2.2.3.7; Appendices B - F).

Applied or application skills are about the ability to use the learnt geometric knowledge and skills in new situations for different reasons that include problem solving, decision making, investigation or making and producing new ideas and products. Hence, to comply with the CAPS, the teaching-learning activities mainly represented by exercises, activities and questions in the grades 4 - 6 Mathematics textbooks were expected to ask learners to create their own geometric patterns and composite 2-D shapes; identify patterns all around us in

nature, from modern every day life and from our cultural heritage; investigate 2-D shapes and their relationships, etc. (see 2.2.3.2; Appendices B - F).

3.6.2.4 CAPS-based data collection strategy, instruments and procedures

The evaluation of the CAPS compliance of every textbook on the topics, concepts and skills of 2-D shapes was done by identifying expositions, explanations, exercises, questions and activities in the textbooks that match, express and comply with the teaching-learning activities in the appendices. Based on the presence or absence of the aspects of the textbooks identified, every teaching-learning activity in each instrument of each grade of the series of textbooks was allocated a score as an indication of its level of compliance to it.

The possible maximum score of every teaching-learning activity in every measuring instrument of every grade is 1 as indicated in brackets at the end of each teaching-learning activity statement in the Appendices B - F. The allocation of the possible maximum score of 1 to a teaching-learning activity of any series of textbook indicates full compliance with CAPS by the particular series. Any score of a series that is different from the indicated possible maximum, with respect to the teaching-learning activity, indicates lack of full compliance with the CAPS. Lack of full compliance points to either a partial compliance evidenced by any score between 1 and 0 or complete lack of compliance with CAPS evidenced by a score of 0 with respect to the corresponding teaching-learning activity.

Hence, the possible maximum and minimum scores of 1 and 0 are the extreme ends of the scoring scale for teaching-learning activities and the partial scores are intermediate scores between the possible maximum score of 1 and minimum score of zero. The partial scores indicating partial compliance with CAPS include 1/2, 1/3, 1/4, 1/5, 1/6 and 1/7 and their multiples, namely, 2/3, 2/4, 3/4, 2/5, 3/5, 4/5, 2/6, 3/6, 4/6, 5/6, 2/7, 3/7, 4/7, 5/7 and 6/7. The partial scores imply that teaching-learning activities having potential for being partially complied with were divided into two until seven smaller aspects that must be individually complied with in order for the whole to be fully complied with. The numbers of aspects to be taken into consideration for full compliance determined the fraction of the whole that each aspect would be represented by. Hence, for teaching-learning activities that could be satisfied half-way, by a third, a quarter, a fifth, a sixth or even a seventh, the corresponding score of 1/2, 1/3, 1/4, 1/5, 1/6 and 1/7, respectively, was allocated to every aspect and a multiple thereof was allocated for the whole teaching-learning activity.

The scoring range of 1 to 0 emanated from the initial idea of using a yes or a no to indicate whether CAPS has been complied with or not by a teaching-learning activity in the textbook.

A closer look at the teaching-learning activities revealed that some cases would not be an obvious yes or no, but in-between, wherein compliance is present but not fully satisfied. This means that compliance would vary from full to partial to zero compliance, where partial compliance would also vary according to the number of specific individual aspects that had to be complied with. Hence, compliance could also range from being small but significant to being noticeable, to major but not completely compliant.

The scoring range of 1 to 0 was preferred over other scoring alternatives like the scoring range of 0, 1, 2, 3, 4, 5, 6 up 7 for several reasons. Firstly, the nature of fractions, unlike the whole numbers, clearly demonstrates the partial compliance because a fraction is part of a whole which is represented by the score of 1 or 2/2, 3/3, 4/4, 5/5, 6/6 or 7/7 in this study. Secondly, since fractions are smaller numbers within the limited 1 to 0 range, they keep the possible scores and total scores of the teaching-learning activities and skills low and not unnecessarily big as the case would be with the whole numbers beyond 1. Every teaching-learning activity that is not satisfied is scored 0 and counts for nothing, while every teaching-learning activity that is fully complied with scores and counts 1 and not 1, 2 up to 6 or 7 as the case would be in the alternative scoring range using whole numbers. In the alternative scoring scale of 0 - 7, full compliance would mostly be represented differently for different teaching-learning activities depending on the numbers of aspects making up the teaching-learning activity. In contrast, the chosen scoring range has only one possible maximum score of 1, indicating full compliance, irrespective of the numbers of aspects to be individually complied with for the whole teaching-learning activity to be complied with.

3.6.3 The Van Hiele level 0 and 1-based measuring instruments

3.6.3.1 Use of the instrument

The Van Hiele-based measuring instrument was used to measure the compliance of the grades 4 - 6 Mathematics (English LOLT) textbooks with the level descriptors of the Van Hiele Theory of Geometric Thought. It was divided into two different instruments represented by Appendices G - I for measuring compliance at Van Hiele level 0 in the grade 4 textbooks, and for measuring compliance at Van Hiele level 1 in the grades 5 and 6 textbooks, respectively. Hence, appendix G, the first Van Hiele-based instrument for the grade 4 textbooks, measures the Van Hiele progression compliance from the foundation phase grades R - 3 to grade 4 in the grade 4 textbooks. Appendices H and I, the second instrument, measures the compliance with Van Hiele level 1 on individual and cumulative textbook level in the grades 5 - 6 textbooks.

Therefore, the grade 4 series textbooks were evaluated only once for the progression of the topics, concepts and skills relating to 2-D shapes from the foundation phase grade R - 3 for the achievement of Van Hiele level 0 descriptors and sample learner responses. The grade 5 and 6 textbooks were then evaluated for their compliance with Van Hiele level 1 descriptors and learner responses at grades 5 and 6. Appendices G, H and I also serve as the corresponding results obtained from the evaluations performed by means of the two differentiated Van Hiele-based measuring instruments used on the grades 4, grades 5 and 6 textbooks respectively.

3.6.3.2 Motivation for the Van Hiele-based measuring instruments

There is some connection between the pedagogical approach and the teaching-learning method (Nieuwoudt, 2006: 15 - 16); hence, the content analysis to determine pedagogical approach of the learner textbooks and teacher's guide, is related to the assessment and learning activities that determine the teaching-learning method (see 2.3.3). Thus, the DBE's second criterion of content analysis, based on sound understanding of how learning takes place and the third criterion of teaching-learning (instructional) method to establish the assessment and learning activities, are related (see 2.3.3). They both support the learning goals of the learner textbooks and teacher's guide (see 2.3.3), but most importantly, the teaching-learning method supports the pedagogical approach.

The Van Hiele Theory of Geometric Thought offers both the pedagogical approach and the teaching-learning method relevant to this research on space and shape. Hence, it is appropriate and well suited as a measuring instrument for both the content analysis and teaching and learning design criteria of the DBE. Its four assumptions and five levels of geometric thought provide the pedagogical approach; the five phases provide both the pedagogical approach and teaching-learning method, while the five specific skills form part of the object of learning. The second and third criteria of evaluating the grades 4 - 6 Mathematics textbooks, namely, content analysis and teaching and learning (instructional) design respectively, are not independent of each other. The content analysis meant to determine the pedagogical approach of the textbooks, is related to the assessment and learning activities which determine the teaching and learning method (see 2.3.3).

3.6.3.3 Description of the Van Hiele-based instrument: The five geometric skills

Appendices G - I are tables which serve the Van Hiele-based measuring instruments. Each of the Appendices G - I evaluated the five geometrical skills, namely, visual skills, verbal and / or written skills, drawing skills, logical skills and applied skills (see 2.2.3.7), all underpinned by specific descriptive level descriptor-learner responses that formed evaluating principles

and aspects of each textbook. The level descriptor-learner responses represent the topics, concepts and skills related to 2-D shapes in the grades 4 - 6 Mathematics CAPS, which must form the contents of the textbooks as part of the textbooks' interpretation and implementation of the intended curriculum (see 2.2.3.7).

The visual skills form section A of each of the five Van Hiele-based measuring instruments. They comprise the ability to recognise, visualise and identify by sight all the relevant combinations of level descriptor and sample learner response aspects in the exposition, explanations, exercises and activities in the textbooks (see Appendices G, H and I). The two main headings of the combination of level descriptor and sample learner responses appropriate and relevant to learners are that learners recognise 2-D shapes, their angles and that they recognise different 2-D shapes in different settings and environments (see Appendices G - I).

The recognition aspect of the visual skills involves two categories. The first category is of recognition of progression from the previous grade and thus revision in a sense, because learners are familiar and have a picture of the topics, concepts and skills their mind. The second category is of recognition of new topics, concepts and skills that exist, that are related or unrelated with the previous, but must be visualised and learnt. In either case, recognition aspects involved must be visibly depicted in drawings and / or written format, or presented as revision or new information and content, including the level descriptor-learner responses and progression of knowledge in the learner book. In the measuring instruments, the visual skills are more than just the ability to interpret figural information and to understand the visual representation and spatial vocabulary. They are instead achieved through the textbook communicating effectively using visual, symbolic and language skills in various modes (see 2.2.2.2). They also provide new knowledge and build on previous knowledge (see 2.3.3).

The verbal and / or written skills form section B of each of the three Van Hiele-based measuring instruments, consist of describing, naming and identifying (verbally and / or through writing) and are the communication skills applicable to only the exercises and activities in the textbooks (see Appendices G - I). To comply with the Van Hiele Theory, the level descriptor-learner response represented by exercises, activities and questions in the grades 4 - 6 Mathematics textbooks were expected to ask learners to describe, identify and name 2-D shapes, patterns, angles, lines of symmetry verbally and / or through writing, according to their characteristics and properties in different specified ways (see 2.2.3.2; Appendices G - I).

The drawing skills form section C of each of the three Van Hiele-based measuring instruments. They consist of drawing, tracing, copying, constructing, putting together, building, tessellating, transforming and are also applicable to exercises and activities only in the textbooks (see Appendices G - I). They are the pencil and paper activities which enable the learners to express their ideas in pictures and diagrams (see 2.2.3.7). To comply with the Van Hiele, the level descriptor-learner responses represented by exercises, activities and questions in the grades 4 - 6 Mathematics textbooks were expected to ask learners to draw, construct, copy, trace, put together, tessellate and transform 2-D shapes, patterns, angles, line(s) of symmetry, etc., according to their characteristics and properties in different specified ways (see 2.2.3.2; Appendices G - I).

The logical skills form section D of each of the Van Hiele-based measuring instruments. They consist of sorting and comparing, are also applicable to exercises and activities only, and provide a sense of justification and reasoning (see 2.2.3.7). To comply with the CAPS, the level descriptor-learner responses represented by exercises, activities and questions in the grades 4 - 6 Mathematics textbooks were expected to ask learners to sort, compare 2-D shapes, patterns, angles, lines of symmetry, etc. according to their characteristics and properties in different specified ways (see 2.2.3.2; Appendices G - I).

The applied skills form section E of each of the three Van Hiele-based measuring instruments. They consist of thinking, reasoning, problem solving, decision making, investigation, creation, making and production; are also applicable to exercises and activities only, and provide the practical use of the geometric knowledge and understanding (see 2.2.3.7; Appendices G - I). Applied or application skills are about the ability to use the learnt geometric knowledge and skills in new situations for different reasons that include problem solving, decision making, investigation or making and producing new ideas and products. Hence, to comply with the CAPS, the level descriptor-learner responses mainly represented by exercises, activities and questions in the grades 4 - 6 Mathematics textbooks were expected to ask learners to create their own geometric patterns and composite 2-D shapes; to identify patterns all around us in nature, from modern every day life and from our cultural heritage; and to investigate 2-D shapes and their relationships, etc. (see 2.2.3.2; Appendices G - I).

3.6.3.4 Van Hiele-based data collection strategy, instruments and procedure

The evaluation of the Van Hiele levels 0 and 1 compliance of every textbook on the topics, concepts and skills of 2-D shapes was done by identifying expositions, explanations, exercises, questions and activities in the textbooks that match, express and comply with the

Van Hiele level descriptors and learner response activities in the appendices. Based on the presence or absence of the aspects of the textbooks identified, every Van Hiele level descriptor and learner response activity in each instrument of each grade of the series of textbooks was allocated a score as an indication of its level of compliance to it.

The possible maximum score of every level descriptor and sample learner response in every measuring instrument of every grade is 1, as indicated in brackets at the end of each level descriptor and sample learner response statement in the Appendices G, H and I. The allocation of the possible maximum score of 1 to a level descriptor and sample learner response of any series of textbook indicates full compliance with Van Hiele theory by the particular series. Any score of a series which differs from the indicated possible maximum, with respect to the level descriptor and sample learner response, indicates lack of full compliance with the Van Hiele theory. Lack of full compliance points to either a partial compliance evidenced by any score between 1 and 0, or complete lack of compliance with the Van Hiele theory evidenced by a score of 0 with respect to the corresponding level descriptor and sample learner response.

Hence, the possible maximum and minimum scores of 1 and 0 are the extreme ends of the scoring scale for the combination of level descriptor and sample learner response and the partial scores are intermediate scores between the possible maximum score of 1 and minimum score of zero (0). The partial scores indicating partial compliance with Van Hiele theory include 1/2, 1/3, 1/4, 1/5, 1/6 and 1/7 and their multiples, namely, 2/3, 2/4, 3/4, 2/5, 3/5, 4/5, 2/6, 3/6, 4/6, 5/6, 2/7, 3/7, 4/7, 5/7 and 6/7. The partial scores imply that the combination of level descriptor and sample learner responses having potential for being partially complied with, were divided into two until seven smaller aspects that must be individually complied with for the whole to be fully complied with. The numbers of aspects to be taken into consideration for full compliance determined the fraction of the whole that each aspect would be represented by. Hence, for the combination of level descriptor and sample learner responses that could be satisfied half-way, by a third, a quarter, a fifth, a sixth or even a seventh, the corresponding score of 1/2, 1/3, 1/4, 1/5, 1/6 and 1/7 respectively was allocated to every aspect, and a multiple thereof was allocated for the whole combination of level descriptor and sample learner response.

3.7 DATA ANALYSIS

3.7.1 The readability measuring instrument

All the grades 4 - 6 Mathematics textbooks are produced and published for the learners in the age groups of 10 - 12 years for the three grades respectively. However, learners a year

younger or two to three years older may also utilise these textbooks. Hence, all these learners must actually be able to read and make sense of the content and context inside the textbooks, and by reverse implication, the textbooks must not be found to be too difficult for the learners to understand (see 2.2.3.5).

The Gunning Fog Readability Test and Index (Burns & Charleston, 1997) were used for this study to calculate the readability of the approved grades 4 - 6 Mathematics textbooks and analyse because it is the best suited for this purpose (see 2.2.3.3). The appropriate Gunning Fog Readability Indices (GFRIs) for the grades 4 - 6 Mathematics (English LOLT) textbooks are given in table 3.1 below as ranging from 3.01 to 6.00, and specifically, 3.01 - 4.00 for grade 4; 4.01 - 5.00 for grade 5 and 5.01 - 6.00 for grade 6 texts.

The corresponding possible GFRIs which are still acceptable for each of the three grades and the age in school, are also given in table 3.1 below as ranging from 0.01 to 6.00, and specifically 0.01 - 4.00 for grade 4; 0.01 - 5.00 for grade 5 and 0.01 - 6.00 for grade 6. Hence both the appropriate GFRIs and the possible and acceptable GFRIs have a minimum and maximum reading within the range. The later GFRI is cumulative to the grades, ranging from the lowest grade R or grade 0 to the grade in question, thus demonstrating that the learner should also be able to read at the lower level she / he has passed, but cannot be expected to read at a higher level.

TABLE 3.1: Gunning Fog Readability Indices (GFRIs) for school Grades 1 - 12 (Gunning, 1952: 38)

Age in School	Grades in school (according to Gr. 1-12)	Appropriate GFRI range	Possible & acceptable GFRI range
7 Years Old	1	0.01 - 1.00	0.01 - 1.00
8 Years Old	2	1.01 - 2.00	0.01 - 2.00
9 Years Old	3	2.01 - 3.00	0.01 - 3.00
10 Years Old	4	3.01 - 4.00	0.01 - 4.00
11 Years Old	5	4.01 - 5.00	0.01 - 5.00
12 Years Old	6	5.01 - 6.00	0.01 - 6.00
13 Years Old	7	6.01 - 7.00	0.01 - 7.00
14 Years Old	8	7.01 - 8.00	0.01 - 8.00
15 Years Old	9	8.01 - 9.00	0.01 - 9.00
16 Years Old	10	9.01 - 10.00	0.01 - 10.00
17 Years Old	11	10.01 - 11.00	0.01 - 11.00
18 Years Old	12	11.01 - 12.00	0.01 - 12.00

Every GFRI of every textbook obtained according to the readability data collection strategy and procedure described in 3.6.1.1 above, was first compared to the appropriate GFRI range according to the grade to see if it fell within it or not. Any GFRI falling outside the appropriate

range was further processed to determine whether it was above or below the range in terms of magnitude. GFRIs below the appropriate range for the grade were then classified as possible and acceptable. All GFRIs that were determined to be falling above the appropriate GFRI range could not be classified further. They were regarded as deviants from both the appropriate as well as the possible and acceptable GFRI norms and standards for the specific grade and age group of the learners, and thus regarded as inappropriate and unacceptable for any textbook to have.

3.7.2 The CAPS-based measuring instrument

An inductive data analysis process was followed with each one of the CAPS compliance measuring appendices B – F, underpinned by their descriptive teaching-learning activities of the topics, concepts and skills of 2-D shapes. After all the scores had been allocated as part of the evaluation according to the data collection strategy and procedure, all scores were added for each skill and arranged as tables 4.4 - 4.8 in raw data and percentage form. Percentages quantified the compliance in comparison to 100% and facilitated decision making on the basis of the level of compliance in percentages.

3.7.3 The Van Hiele level 0 and 1-based measuring instrument

Similar to the data analysis of the CAPS-based measuring instrument, an inductive data analysis process was followed with everyone of the Van Hiele level 0 and 1 compliance measuring Appendices G – I, underpinned by their descriptive level descriptors-learner responses activities of the topics, concepts and skills of 2-D shapes. After all the scores had been allocated as part of the evaluation according to the data collection strategy and procedure, all scores were added for each skill and arranged as tables 4.9 - 4.11 in raw data and percentage form. Percentages quantified the compliance in comparison to 100% and facilitated decision making on the basis of the level of compliance in percentages.

3.8 SCOPE AND LIMITATIONS

The scope of the study is limited to only the intermediate phase's grades 4 - 6 Mathematics, within the General and Education Training (GET) Band of the South African National Qualifications Framework (NQF). Hence, it is limited in a number of ways, including the grades, the subject, the language of learning and teaching (LOLT) and textbooks.

Apart from the grade 3 and grade 7 specifications of content, most of the foundation phase grades R - 3 and the senior phase grades 7 - 9 are excluded. However, the findings are not only specific to the grades 4 - 6 Mathematics textbooks, but to all textbooks, workbooks and learning support materials in general, particularly for the scarce skills content subjects. The

conclusions, recommendation and implications of the study reveal many opportunities for further research, pertaining to educational policy.

3.9 ETHICAL ASPECTS

This study did not involve any experimental methods or intervention, hence no permission for access or consent of participation had to be sought from a teacher, school or even the DBE. It was not sensitive or intrusive either since no human participants were at all involved, except for the researcher. The only ethical aspects that were and will continually be taken into consideration during and after the research process were and still are:

3.9.1 The names of the textbooks being evaluated will have to be kept secret from the non-participants and general public in order to avoid any undue response from publishers, author(s) and / or market about the review and evaluation processes and results.

3.9.2 Proper feedback in the form of a research report of findings will be given to the officials of the Department of Basic Education and the publishers and / or authors. The feedback may be in the form of the dissertation itself after approval.

3.10 SYNOPSIS AND CONCLUSION

An account of the framework within which this research and study was conducted was given in this research design and methodology chapter. The limitation of the research is to the English language readability, CAPS compliance and Van Hiele levels 0 and 1 descriptors and sample learner responses. The combined conceptual analytical and document analysis research design was chosen and used for this qualitative study. An inductive data analysis process chosen was followed with both the CAPS-based compliance and Van Hiele-based measuring instruments, underpinned by the researcher's socio-constructivist perspective. This chapter concludes with the very limited ethical considerations of the research.

CHAPTER 4
RESEARCH FINDINGS OF THE TEXTUAL ANALYSIS

4.1 INTRODUCTION

In this chapter, the results of evaluating five of the eight approved grades 4 - 6 Mathematics (English LOLT) learner textbooks, based on the four criteria of curriculum content, content analysis, teaching and learning design and appropriate English LOLT level are presented. Even though the word “textbook” is mostly synonymous with the learner’s book, the learner’s book is not entirely independent from the corresponding teacher’s guide, hence, it was considered incomplete without the teacher’s guide (DBE, 2012a: 3). Therefore, the word textbook is used to represent both the learner’s book as well as the teacher’s guide in this study, particularly where the teacher’s guide further reveal the intentions, level and amount of curriculum content, content analysis and teaching and learning design.

The curriculum content results present the level and amount of curriculum content alignment with the grades 4 - 6 CAPS document (see 2.3.3), hence a CAPS-based measuring instrument was utilised to obtain the result. The content analysis results present the pedagogic approach as well as the teaching and learning (instructional) design of the Van Hiele Theory of Geometric Thought which the researcher deems relevant and appropriate to the research, hence the Van Hiele-based measuring instrument was used to obtain the results (see 3.2.3.2). The results of the appropriate English LOLT level for grades 4 - 6 and age group levels 10 - 12 years present readability and specifically the level of ease of reading and understanding of the text in each textbook and are presented by means of the Gunning Fog document readability test.

The results are presented for each of the five approved learner textbook series, under the three measuring instruments of readability, compliance with CAPS and compliance with the Van Hiele Theory of Geometric Thought. Hence, under each measuring instrument, the results will be presented for the grade 4, then grade 5 and lastly the grade 6 textbooks of every series of textbooks. The intention is to present an evaluation report of every textbook and series of textbooks as it pertains to every instrument with its own specific content and context. Thereafter, an overall conclusion will be presented about the contribution of each one of the grades 4 - 6 Mathematics learner textbooks towards the development of the conceptual knowledge and understanding of 2-D shapes.

The five series of learner textbooks evaluated are not identified by either their names or publishers in this chapter and research, but are instead referred to as series 1 - 5. Thus,

each of the five grade 4, five grade 5 and five grade 6 learner textbooks evaluated are identified either as grade 4, 5 or 6 Mathematics learner textbooks of series 1, 2, 3, 4 and 5, represented respectively as S 1, S 2, S 3, S 4 and S 5.

4.2 CHAPTER PERSPECTIVE AND PRELUDE TO FINDINGS

According to the terms of reference and guidelines by which the grades 4 - 6 Mathematics textbooks were submitted for evaluation and adoption in the national catalogue, every textbook should focus on teaching the topics, concepts, skills and communicate the knowledge stated in the grades 4 - 6 Mathematics CAPS document (DBE, 2012a: 12). They must also be written at an appropriate English LOLT reading level for the intended grade and age of the learners. Furthermore, every textbook must include a clear explanation of new terms and use them a few times in well constructed sentences to ensure understanding of the context and proper use of the new vocabulary (DBE, 2012a: 12).

By implication, any grade 4 - 6 Mathematics textbook found lacking in the areas of either the appropriate English LOLT reading level, teaching and learning activities in compliance with the CAPS and / or clear explanation and use of new terms, will not be fulfilling its role. Such a textbook will not be meeting its intended purpose, thus not fit for its purpose, should not be depended upon to interpret and give meaning to the intended curriculum for the schools.

4.3 THE READABILITY MEASURING INSTRUMENT

The readability of the grades 4 - 6 Mathematics (English LOLT) learner textbooks is a useful way to gauge whether a message is written at a suitable level for the intended and mostly 10 - 12 year old learners (see 2.2.3.3).

The appropriate English language reading level for the grade and age group of the learners is required by both the terms and references for submission of learning and teaching support material and the evaluation form of the DBE (2012a: 5), for all of the text in each one of the textbooks. Hence, all text in all the chapters, units and / or topics of the textbook, including the introductions, explanations, activities and questions in all grades 4 - 6 textbooks, must consistently be easy to read with understanding for the learners and the age level groups in the corresponding grades. This consistency of ease of reading with understanding is required within every textbook and consequently, it is also required in the series of the three grades 4 - 6 Mathematics textbooks.

In this study, readability was the first evaluation conducted in order to decide whether each learner's textbook is fit or not for the purpose of being a learning and teaching tool. Any

textbook with an English language readability level too high for the grade and age level of the learners it is intended for, was deemed to be an ineffective learning and teaching tool. Furthermore, it was deemed incapable to contribute toward the development of the conceptual understanding of 2-D shapes, with its readability the specific barrier to learning and teaching.

Two actual GFRIs of each grade 4 - 6 textbook have been determined in line with the descriptions in Chapter 3 (see 3.6.1.1), and the results are presented in Appendix A. The abbreviated versions of Appendix A are tables 4.1, 4.2 and 4.3 below. The passages used to determine the GFRIs varied in size, in terms of the number of words in the passage, from 47 to 133 words. The passages were identified from specific teaching-learning activities or groups of teaching-learning activities, as well as sections that explain the content and knowledge in the textbook. Two determined GFRIs means that more than just one GFRI per grade 4 - 6 Mathematics textbook was determined to check the consistency of the readability of each textbook.

Ideally, three or four GFRIs from each textbook would give a better indication of the consistency of its readability and the extent of deviation (if any) of each GFRI from the appropriate GFRI for the grade and age and from each other. However, not all the textbooks consistently gave a continuous passage of approximately 100 words, which is the size needed to determine the GFRI. In fact, there is no maximum and minimum number of words given as the appropriate size of a continuous passage to be used to determine a reliable GFRI. The operative expression for the size of the passage from literature is “around 100 words” (see 3.6.1.1). The smallest passages of47, followed by 62 words, are both from the grade 4 series 3 textbook. The passage of 47 words is considered an outlier by the researcher when compared to the rest of the passages ranging from 62 - 133.

It is important to know that the number of words in a passage of about 100 words includes both the readable traditional English words in an explanation (exposition), summary or activities in the textbook series, as well as the numbering in all its formats. This is because the online GFRT calculator reads the numbering in all its formats as words, but does not read the bullets likewise. Hence, the number of words as counted by the researcher is lower and different from the number of words as counted by the online GFRT calculator in the activities taken from the textbooks because the activities are labelled with numbers, letters of the alphabet or a combination of numbers and letters of the alphabet like “1.; a.”; or “1a”.

The headings of the explanations (expositions) or activities were not included as part of the passage because they would also be counted as words forming part of the passage by the online GFRT calculator. The numbering of activities was included in the passage because they form part of the overall structure of the activities, but also because the GFRIs of most activities increased when the numbering was left out.

The following sections, 4.3.1, 4.3.2 and 4.3.3, are the presentations, interpretations and analysis of the GFRI results of the grades 4, 5 and 6 textbooks respectively. The tables reflecting the two calculated GFRIs of each grade 4, 5 and 6 textbook and series form part of each of the sections 4.3.1, 4.3.2 and 4.3.3 below. The tables in each section are abbreviated versions of Appendix A, each separately presenting the grade 4, 5 and 6 GFRIs from each textbook. The tables also summarise the results of whether both GFRIs of each series of textbook are consistent or inconsistent and give a reason(s) for the consistency, inconsistency or inappropriateness thereof.

4.3.1 Grade 4 Series Gunning Fog Readability Index (GFRI) Results

The following is a presentation of the GFRI results of the evaluation of two paragraphs ranging from 47 to 116 words from the five grade 4 series of textbooks, as calculated by the online GFRI calculator. The calculated GFRIs are presented in Table 4.1 below according to each series of textbook, and a discussion of the GFRIs of each series follows the table.

Table 4.1: Calculated Gunning Fog Readability Indices (GFRIs) for school grade 4 of textbook series 1 – 5

Grade 4 Series GFRI Results for 10 year old learners									
Appropriate GFRI range is of order 3.01 – 4.00 for the Age & School Grade									
Possible & Acceptable GFRI range is of order 0.01 – 4.00 for the Age & School Grade									
S 1		S 2		S 3		S 4		S 5	
6.15	2.51	3.57	3.76	10.57	3.10	5.91	5.85	3.21	5.25
Inconsistent GFRIs (1 GFRI inappropriate)		Consistent GFRIs (both appropriate)		Inconsistent GFRIs (1 GFRI inappropriate)		Inappropriate GFRIs (both outside range)		Inconsistent GFRIs (1 GFRI inappropriate)	

Only the determined GFRIs of series 2 are both at the appropriate GFRI level of 3.01 - 4.00 as required for grade 4 and age level of 10 year old learners. Determined as 3.57 and 3.76, the GFRIs of series 2 are both decimal numbers between 3.01 and 4.00. They are both at the upper half of the 3.01 - 4.00 range since they are above the half-way reading of 3.50, and demonstrate a readability which is slightly more difficult than one below 3.50 but nevertheless appropriate, possible and acceptable. Therefore, the two GFRIs indicate that series 2 has a consistent and appropriate readability level; that grade 4 learners will be able

to read the text in it with ease and understanding on their first reading (see 2.2.3.3). Reading with ease and understanding is expected to facilitate and enable the series to contribute towards the development of the conceptual understanding of 2-D shapes.

Both determined GFRIs of series 1 are not at the appropriate GFRI level range of 3.01 - 4.00, but one is below the lower limit of 3.01 of the range, and the other is above the higher limit of 4.00. Determined as 2.51 and 6.15, the first GFRI of 2.51 is below the appropriate GFRI level of 3.01 - 4.00 for grade 4 and is appropriate for the lower grade 3 instead of grade 4, because it matches the grade 3 GFRI level range of 2.01 - 3.00. Even so, the determined GFRI of 2.51 is possible and acceptable for grade 4 because it is in the possible and acceptable GFRI level range of 0.01 - 4.00 for grade 4 (see table 3.1). However, the second determined GFI of 6.15 is higher than the appropriate grade 4 levels GFRI range of 3.01 - 4.00, and is appropriate for the higher grade 7 levels because it matches the grade 7 GFRI level range of 6.01 - 7.00 and not grade 4 levels. Unlike the lower GFRI of 2.51, the higher GFRI of 6.15 for series 2 is neither appropriate nor possible and acceptable for grade 4 learners who cannot be expected to read the text with ease and understanding at a higher grade and age level than grade 4 and 10 year age level. Therefore, series 1 offers an inconsistent readability level, with one passage with the GFRI of 2.51 extremely easy to read with understanding and the next passage with the GFRI of 6.15 being extremely difficult to read with understanding.

Series 3 and 5 have one GFRI at the appropriate level for grade 4 and the other outside and higher than the appropriate grade 4 GFRI level range of 3.01 - 4.00. The determined GFRIs of 3.10 and 3.21 for series 3 and 5 respectively, are appropriate, while 10.57 and 5.25 respectively are neither appropriate nor possible and acceptable. The two inappropriate and unacceptable GFRIs of 10.57 and 5.25 are respectively at grades 10 and 6 levels, because they respectively match the GFRIs of ranges 10.01 - 11.00 and 5.01 - 6.00 of the said higher grade levels and not GFRI level range of 3.01 - 4.00 for grade 4. Similar to series 1 above, series 3 and 5 offer an inconsistent readability, with one passage of GFRI within the range 3.01 - 4.00 being readable with ease and understanding as required, but the next passage with GFRI outside the range of 3.01 - 4.00 being extremely difficult to read with ease and understanding.

Both determined GFRIs for series 4 are outside and higher than the appropriate grade 4 level GFRI range of 3.01 - 4.00. The two GFRIs of 5.91 and 5.85 are neither appropriate nor possible and acceptable because they both match the grade 6 level GFRI range of 5.01 - 6.00. Similar to all the other GFRIs which are higher than the upper limit of the

appropriate grade 4 level GFRI, these two render series 4 difficult to impossible to read with ease and understanding.

While not desirable, inconsistent readability for series 1, 3 and 5 offers a dichotomy of good and bad readability results in a sense that the passages that are either appropriate or possible and acceptable will be read with ease and understanding and those that are neither appropriate nor possible and acceptable will not be. Therefore, some parts of the textbooks are expected to facilitate and enable the series to contribute towards the development of the conceptual understanding of 2-D shapes, while others are not. Overall, the series are judged not be able to contribute towards the development of the conceptual understanding of 2-D shapes mainly due to the inconsistent readability they offer.

Series 4 whose readability is consistently two grades higher holds no hope at all for the grade 4 learners. Unlike series 1, 3 and 5, it offers readability results that are entirely unsatisfactory and which are neither expected to facilitate nor enable the series to contribute towards the development of the conceptual understanding of 2-D shapes. It is no doubt the publication which, according to Burns & Charleston (1997: 297, would not be an appropriate choice, irrespective of what other favourable qualities it possesses (see 2.2.3.3).

4.3.2 Grade 5 Series Gunning Fog Readability Index (GFRI) Results

The following is a presentation of the GFRI results of the evaluation oftwo paragraphs ranging from 67 to 134 words from the five grade 5 series of textbooks, as calculated by the online GFRI calculator. The calculated GFRIs are presented in Table 4.2 below according to each series of textbook, and a discussion of the GFRIs of each series follows the table.

Table 4.2: Calculated Gunning Fog Readability Indices (GFRIs) for school grade 5 of textbook series 1 – 5

Grade 5 Series GFRI Results for 11 year old learners									
Appropriate GFRI range is of order 4.01 – 5.00 for the Age & School Grade									
Possible & Acceptable GFRI range is of order 0.01 – 5.00 for the Age & School Grade									
S 1		S 2		S 3		S 4		S 5	
9.62	6.41	10.08	4.86	2.99	5.96	6.73	10.99	4.06	4.77
Inappropriate GFRIs (Both outside range)		Inconsistent GFRIs (1 GFRI inappropriate)		Inconsistent GFRIs (1 GFRI inappropriate)		Inappropriate GFRIs (Both outside range)		Consistent GFRIs (Both appropriate)	

Only the determined GFRIs for series 5 are both at the appropriate GFRI level range of 4.01 - 5.00 as required for grade 5 and age level of 11 year old learners. Determined as 4.06 and 4.77, the GFRIs of series 5 are both decimal numbers between 4.01 and 5.00.

Therefore, based on the two GFRIs, the grade 5 learners using this series will be able to read series 5 with ease and understanding. Reading with ease and understanding is expected to facilitate and enable the series to contribute towards the development of the conceptual understanding of 2-D shapes.

Series 2 and 3 have one GFRI at either the appropriate or possible and acceptable GFRI level and the other GFRI outside and higher than the appropriate GFRI level range of 4.01 - 5.00 for grade 5 at 11 years of age. The determined GFRI of 4.86 for series 2 is appropriate for grade 5 since it matches the grade 5 GFRI range, but the other determined GFRI of 10.08 is higher and far outside the range since it matches the GFRI level of grade 11 instead of grade 5. For series 3, the determined GFRI of 2.99 is not appropriate for grade 5 since it is below the appropriate GFRI range of 4.01 - 5.00. However, it is possible and acceptable since it matches the possible and acceptable GFRI range of 0.01 - 5.00 for grade 5. The corresponding GFRI of 5.96 for series 3 is outside and higher than the grade 5 GFRI range, thus, not appropriate for a grade 5 textbook. Therefore, series 2 and 3 offer inconsistent readability since one of the GFRIs demonstrates either easy or extremely easy reading and the other GFRI demonstrates difficult to extremely difficult reading.

Both determined GFRIs for series 1 and 4 are outside and higher than the appropriate grade 5 level GFRI range of 4.01 - 5.00. The two GFRIs of 9.62 and 6.41 for series 1 and 6.73 and 10.99 for series 4, are neither appropriate nor possible and acceptable. The GFRIs 9.62 and 10.99 for series 1 and 2 respectively, and match the grades 10 and 11 appropriate GFRIs ranges of 9.01 - 10.00 and 10.01 - 11.00 respectively. Similarly, the corresponding second GFRIs of 6.41 and 6.73, for series 1 and 4 respectively, are neither appropriate, nor possible and acceptable. They both match the grade 7 GFRI range of 6.01 - 7.00. Both GFRIs of series 1 and 4 render the two series difficult to read with understanding.

In conclusion, the inconsistent readability of series 2 and 3 offer a dichotomy of good and bad readability results because the passages that are either appropriate or possible and acceptable will be read with ease and understanding and those that are neither appropriate nor possible and acceptable will not be. Therefore, some parts of the textbooks are expected to facilitate and enable the series to contribute towards the development of the conceptual understanding of 2-D shapes, while others are not. Overall, the series are judged not to be able to contribute towards the development of the conceptual understanding of 2-D shapes mainly owing to the inconsistent readability they offer.

Series 1 and 4 whose readability is consistently one to six grades higher hold no hope at all for the grade 5 learners. Unlike series 2 and 3, series 1 and 4 offer readability results that are entirely inappropriate and unacceptable, which are not expected to facilitate nor enable the series to contribute towards the development of the conceptual understanding of 2-D shapes. These are no doubt the publications which according to Burns & Charleston (1997: 291) would not be appropriate choices, irrespective of what other favourable qualities they possess (see 2.2.3.3).

4.3.3 Grade 6 Series Gunning Fog Index (GFRI) Results

The following is a presentation of the GFRI results of the evaluation of two paragraphs ranging from 89 to 133 words from the five grade 6 series of textbooks, as calculated by the online GFRI calculator. The calculated GFRIs are presented in Table 4.3 below according to each series of textbook, and a discussion of the GFRIs of each series follows the table.

Table 4.3: Calculated Gunning Fog Readability Indices (GFRIs) for school grade 6 of textbook series 1 – 5

Grade 6 Series GFRI Results for 12 year old learners									
Appropriate GFRI range is of order 5.01 – 6.00 for the Age & School Grade									
Possible & Acceptable GFRI range is of order 0.01 – 6.00 for the Age & School Grade									
S 1		S 2		S 3		S 4		S 5	
8.56	6.85	6.43	3.71	4.82	2.24	10.61	4.91	6.91	6.43
Inappropriate GFRIs (Both outside range)		Inconsistent GFRIs (1 GFRI inappropriate)		Consistent GFRIs (Both appropriate)		Inconsistent GFRIs (1 GFRI inappropriate)		Inappropriate GFRIs (Both outside range)	

The determined GFRIs of 4.82 and 2.24 for series 3 are both not at the appropriate GFRI level of range 5.01 - 6.00 for grade 6 and age of 12 years old because they are both lower than the lower limit of the GFRI range. However, both indicate easy and extremely easy reading levels for the series, and match the possible and acceptable GFRI range of 0.01-6.00 for grade 6. Thus, the readability of series 3 is expected to facilitate and enable the series to contribute towards the development of the conceptual understanding of 2-D shapes.

Both determined GFRIs for series 1 and 5 are outside and higher than the appropriate grade 6 level GFRI range of 5.01 - 6.00. The two GFRIs of 8.56 and 6.85 for series 1 and 6.91 and 6.43 for series 5, are neither appropriate nor possible and acceptable GFRIs for grade 6 textbooks. The GFRIs 8.56 and 6.85 for series 1 are at grades 9 and 7 levels respectively since they match the 8.01 - 9.00 and 6.01 - 7.00 ranges, while the GFRIs of series 2, viz., 6.91 and 6.43, are both at grade 7 level since they both match the grade 7 GFRI range of

6.01 - 7.00. The GFRIs of both series 1 and 5 render the two series difficult to read with understanding.

Both determined GFRIs of series 2 and 4 are not at the appropriate GFRI level range of 5.01 - 6.00 for grade 6. Determined as 3.71 and 6.43, 10.61 and 4.91, for series 2 and 4 respectively, the GFRI of 3.71 and 4.91 are both below the appropriate GFRI level for grade 6, while GFRIs of 6.43 and 10.61 are both above the appropriate GFRI level of grade 6. Though not appropriate, the GFRIs of 3.71 and 4.91 of series 2 and 4 respectively, are possible and acceptable for grade 6 textbooks because they match the possible and acceptable GFRI level of 0.01 - 6.00 for grade 6. However, the GFRIs of 6.43 and 10.61 for series 2 and 4 respectively, are neither appropriate nor possible and acceptable since they are higher and outside the grade 6 GFRI range. The GFRI of 6.43 is at the grade 7 level, while the GFRI of 10.61 is at the grade 11 level. Therefore, series 2 and 4 offer inconsistent reading levels evident in the inconsistent GFRIs, with one providing for extreme ease of reading with understanding and the other providing the opposite difficult to extremely difficult reading with understanding.

The inconsistent readability of series 2 and 4 offers a dichotomy of good and bad readability results because the passages whose GFRIs are possible and acceptable will be read with ease and understanding, and those whose GFRIs are neither appropriate nor possible and acceptable will not be. Therefore, some parts of the textbooks are expected to facilitate and enable the series to contribute towards the development of the conceptual understanding of 2-D shapes, while others are not. Overall, the series seem not to be able to contribute towards the development of the conceptual understanding of 2-D shapes mainly due to the inconsistent readability they offer.

In conclusion, series 1 and 5 whose readability is consistently one to three grades higher, holds no hope at all for the grade 6 learners. Unlike series 2 and 4, series 1 and 5 offer the readability results that are both entirely inappropriate and unacceptable and which are not expected to facilitate or enable the series to contribute towards the development of the conceptual understanding of 2-D shapes. These are no doubt publications which, according to Burns & Charleston (1997:297), would not be appropriate choices, irrespective of what other favourable qualities they possess (see 2.2.3.3).

4.4 THE CAPS-BASED MEASURING INSTRUMENT

4.4.1 Evaluation results

The evaluation results of the grades 4 - 6 Mathematics textbooks according to the five CAPS-based measuring instruments are presented in two different formats, namely, the long format of Appendices B - F and the short format of tables 4.4 - 4.8 below. Appendices B - F provide the full extent of results of the evaluation of the five grades 4 - 6 series of textbooks on the CAPS-based teaching-learning activities and their corresponding five geometric skills on the relevant topics, concepts and skills. Tables 4.4 - 4.8 are the shortened versions of Appendices B – F, only summarising the data about the skills without the teaching-learning activities they comprise Tables 4.4 – 4.8 have been incorporated into the sections giving the results of every textbook according to grade and series.

In contrast to the appendices, the tables within every section below, only provide two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 4 - 6 series of textbooks' coding and scores (raw and percentages) allocated to each textbook during the evaluation. The individual scores of each series corresponding to the geometric skills are given in the tables for comparison with the possible maximum scores of each geometric skill, and with one another. The total scores of each series on all geometric skills are also given for comparison with the possible maximum scores of all the geometric skills and with one another.

4.4.1.1 Grade 4 CAPS progression compliance from grade 3 to grade 4

The progression of the topics, concepts and skills takes place from simple to complex within a grade, and from a lower grade to a higher one for each content area (DBE, 2011b: 4, 12). Even so, in certain topics, the concepts and skills may be similar in two or even three successive grades (DBE, 2011b: 12). Progression should provide the important link within the grade, but also between grades.

Unlike the general content focus for space and shape (geometry), the specific content focus of space and shape is not the same for the foundation, intermediate and senior phases, but varies from the foundation to the intermediate and to the senior phase. With regard to 2-D shapes, learners in the foundation phase grades R - 3 focus on recognition and simple description of characteristics and properties (see 2.2.2.2). Hence, they explore the properties of 2-D shapes by sorting, classifying, describing and naming them. They also recognize, describe and draw mathematical shapes in their environment and use the appropriate vocabulary (DBE, 2011a: 10). Hence, as part of progression, certain specific and relevant

topics, concepts and skills of grade 3 forming a link with those of grade 4 are expected to form an important part of the grade 4 Mathematics textbook.

Appendix B provides the full extent of results of the evaluation of the five grade 4 series of textbooks on the CAPS-based teaching-learning activities and their corresponding five geometric skills on the progression of the topics, concepts and skills from grade 3 to grade 4.

Therefore, Appendix B, and the teaching-learning activities it consists of, are the topics, concepts and skills of grade 3 contained in the grade R - 3 CAPS document (DBE, 2011a: 24 - 27; 365 - 399), which are relevant for progression from grade 3 to grade 4. The amount of these grade 3 topics, concepts and skills in the grade 4 textbooks is an indication of the extent of progression and link between the lower grade 3 and higher grade 4 (DBE, 2011b: 4, 12). The progression contributes towards the development of conceptual understanding of 2-D shapes in grade 4 and beyond; hence it is important to establish its existence or lack thereof as a possible enabler or hindrance to the development of conceptual understanding of 2-D shapes.

Table 4.4 below is a shortened version of Appendix B. It is divided into two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 4 series of textbooks' coding and scores (raw and percentages) allocated to each textbook during the evaluation. As represented in the CAPS measuring tool in Appendix B, the five geometric skills are underpinned by the teaching-learning activities that should be provided to learners in the textbooks. The five grade 4 textbooks which are the first in the series of three grades 4, 5 and 6 textbooks evaluated, are designated S 1, S 2, S 3, S 4 or S 5, where S is an abbreviation of the word "series".

The scores obtained by each grade 4 textbook of the series during the evaluation are listed under the grade 4 textbook's series designation to correspond with each skill in Table 4.4 and with both the specific skill and teaching-learning activity in Appendix B. In both Appendix B and Table 4.4, the scores and total scores of each grade 4 textbook of the series have been entered side by side in columns for comparison with one another and the possible maximum scores on the specific skill. The total scores of each grade 4 series textbook is provided at the bottom of each column of the grade 4 textbook scores and can also be compared with one another and with the possible maximum total score for the five geometric skills. An account of why each geometric skill in Table 4.4, based on its component teaching-learning activities, has not obtained a perfect score, follows the table in the same order that the skills and results are presented in the table and Appendix B. The amount of score by

which each skill has come short of the possible maximum score depends on the score(s) of the individual teaching-learning activities in Appendix B that were either partially or completely not complied with by the textbook contents as expected by the CAPS.

The specific teaching-learning activities in Appendix B which are not fully complied with by the textbooks, as indicated by a partial or a zero score instead of a full score of 1.00, are also named as part of giving the results of every skill for every series of textbook, but also as identifying how the lack of compliance resulted; can be verified and then corrected. The numbers of aspects needed for full compliance by textbooks, have been included in brackets or written in italics in Appendix B, in the relevant teaching-learning activity.

Table 4.4: Grade 4 textbook series' percentage CAPS compliance: progression from grade 3 to 4

GEOMETRIC SKILLS	Grade 4 series coding and scores (raw and %) for progression				
	S1	**S 2**	**S 3**	**S 4**	**S 5**
A. Visual Skills Score **:** 9.00	8.75 (97%)	8.17 (91%)	6.50 (72%)	6.75 (75%)	7.50 (83%)
B. Verbal / Written Skills Score **:** 17.00	12.75 (75%)	14.00 (82%)	13.00 (76%)	13.50 (79%)	12.25 (72%)
C. Drawing Skills Score **:** 8.00	7.50 (42%)	9.00 (50%)	10.50 (58%)	12.75 (71%)	9.25 (51%)
D. Logical Skills Score **:** 3.00	3.00 (100%)	3.00 (100%)	3.00 (100%)	3.00 (100%)	3.00 (100%)
E. Applied Skills Score **:** 5.00	3.00 (60%)	2.00 (40%)	2.00 (40%)	2.00 (40%)	3.00 (60%)
TOTAL SCORES : 52.00	35.00**(67%)**	36.17**(70%)**	35.00**(67%)**	38.00**(73%)**	35.00**(67%)**

The CAPS-based measuring instruments use the terms polygon, regular and irregular polygon; the names of the types of triangles according to sides (equilateral, isosceles and scalene triangle) and the specific names of the other quadrilaterals (kite, parallelogram, rhombus, trapezium) for the purpose of clarity, fully aware of the CAPS teaching-learning guidelines concerning them.

4.4.1.1.1 Visual skills score (*Possible: 9.00*)

The following are the results of the evaluation based on Appendix B and the specific teaching-learning activities A 1.1 - 1.7. The abbreviated version of these results is section A of Table 4.4 above and the full version is in section A of Appendix B. The evaluation revealed that all the teaching-learning activities not allocated a perfect score of 1 lacked the visual skills of the 2-D shapes as given below.

Series 1 only shows one position for all the squares available for recognition and visualisation, instead of two possible positions required for compliance with A 1.3. All the squares are drawn with the base side horizontal and none with their angles on the horizontal; hence, the loss of 1/4 (0.25) score on account of a missing second position. Its total score of 8.75 is a 97% CAPS compliance on the visual skills.

Series 2 lacks another equilateral triangle of a different size and position to comply with A 1.2i on the equilateral triangles. The only two equilateral triangles recognised in the series are identical in size and position; hence, the loss of a 2/4 (0.50) half score. Furthermore, there is a lack of an example of multiple symmetries in non-geometrical shapes for compliance with A 1.6, resulting in a 1/3 (0.33) less score. The overall series score of 8.17 is thus 0.83 less than the maximum total possible score for the skill and represents a 91% CAPS compliance.

Series 3 lacks a second equilateral triangle with a different size and position to the one recognised, in A 1.2i, hence, the loss of a 2/4 (0.50) score. It entirely lacks two scalene triangles in two different sizes and positions as well in A 1.2iii, and thus the zero score. There is nothing to recognise on paper folding for symmetry for A 1.7, resulting in the loss of the full score. The overall skill score of 6.50 is thus 2.50 less than the maximum possible score the skill and represents a 72% CAPS compliance of the visual skill.

Series 4 lacks an equilateral triangle in a different position to the one recognised, hence the loss of only 1/4 (0.25) for position alone in A 1.2i. It lacks both a second square and a rectangle of a different size and position to the ones recognised, in A 1.3 and A 1.4, hence, the loss of a 2/4 (0.50) score in both. Furthermore, series 4 has nothing to recognise on paper folding for symmetry for A 1.7, resulting in the loss of the full score and an overall score of 6.75, which is 2.25 less than the maximum total possible score for the skill. The CAPS compliance level for the series of the skill is 75%.

Series 5 lacks an equilateral triangle of a different size and position to the one recognised in A 1.2i, thus lost a 2/4 (0.50) score. It also lost the full score for the absence of any paper folding for symmetry in A 1.7. The series' overall score of 7.50 is 1.50 less than the maximum possible score for the skill and represents an 83% CAPS compliance of the visual skill.

4.4.1.1.2 Verbal / written skills score *(Possible: 17.00)*

The names of the different types of triangles are not necessary for B 1.2, but their drawings are very important. B 4.1 and B 4.2 should be exercises that request the learner's own initiative, ideas and choice of the pattern and not one already drawn, recognised and visualised in the textbook.

The following are the results of the evaluation based on Appendix B and the specific teaching-learning activities B 1.1 - 1.4; B 2.1 - 2.4; B 3.1 - 3.2; B 4.1 - 4.2 and B 5.1 - 5.2. The abbreviated version of these results is section B of Table 4.4 above, and the full version

is in Appendix B. The evaluation revealed that all the teaching-learning activities not allocated a perfect score of 1 lacked the verbal / written skills of the 2-D shapes as given below.

Series 1 neglects to name / identify a second equilateral triangle of a different size and position as well as another isosceles triangle of a different size and position in B 1.2i and B 1.2ii respectively, thus losing a 2/4 (0.50) scores for each. It furthermore neglects to name a square in a different position, thereby losing a 1/4 (0.25) score, since all the other squares were in one position in B 1.3. The learners are never required to describe their own or given simple and complex patterns in B 4.1, 4.2 and B 5.3, hence the loss of the full score in all three. The overall score of 12.75 is 4.25 less than the maximum possible for the skill and represents a 75% CAPS compliance of the skill.

Series 2 has no activities to name the only equilateral triangle in B 1.2i, hence the loss of the full score. It neglects to require the learners to describe their own simple and complex patterns in B 4.1 and B 4.2, thus the loss of the full scores again respectively. The overall score of 14.00 is 3.00 less than the maximum possible score for the skill and an 82% CAPS compliance.

Series 3 only names one equilateral triangle with one size and position as well as one scalene triangle of one size and position, instead of two triangles in each case in B 1.2i and B 1.2ii respectively, hence losing a 2/4 (0.50) score for each. Furthermore, series 3 requires no description of own simple and complex geometric patterns in B 4.1 and B 4.2 and own or given geometric pattern all around us from our culture in B 5.3, thus earning no score in each case. The result is an overall score that is 4.00 less than the maximum possible score for the skill and a 76% CAPS compliance.

Series 4 lacks an equilateral triangle in a different position from that of the three equilateral triangles therein and loses a 1/4 (0.25) score in B 1.2i. It lacks two isosceles triangles of different sizes and positions in B 1.2ii hence the zero score, and also lacks a square of a different size from the existing ones in B 1.3 in order to receive the 1/4 (0.25) score needed for a full score. Furthermore, series 4 requires no description of own simple and complex geometric patterns in B 4.1 or B 4.2, thus earning no score in each case. The result is an overall score that is 3.50 less than the maximum possible score for the skill and a 79% CAPS compliance.

Series 5 pays no attention to identification of circles of different sizes in B 1.1, hence a zero score; has only one equilateral triangle in one position and size in B 1.2i, thus losing a 2/4 (0.50) score, and all squares identified have the same position in B 1.3, losing a 1/5 (0.25) score. It lacks the description of own simple and complex geometric patterns made with drawings of lines, shapes or objects in B 4.2, as well as the description of own or given patterns in nature and cultural heritage in B 5.1 and B 5.3, thus the zero scores in all three cases. The overall score is 4.75 less than the maximum possible score for the skill and a 72% CAPS compliance.

4.4.1.1.3 Drawing skills score *(Possible: 18.00)*

The following are the results of the evaluation based on Appendix B and the specific teaching-learning activities C 1.1 - 1.4; C 2.1 - 2.3; C 3.1 - 3.6 and C 4.1 - 4.3. The abbreviated version of these results is section C of table 4.4 above and the full version is in Appendix B. The evaluation revealed that all the teaching-learning activities not allocated a perfect score of 1 lacked the drawing skills of the 2-D shapes as given below.

Series 1 has no instruction for learners to draw a circle or two circles of different sizes, hence the zero score in C 1.1, and has no triangles of any type drawn in different positions and sizes in C 1.2 i - iii, thus losing 3 full scores. It has squares and rectangles drawn in different sizes, but all maintained in one and the same position, hence the loss of a 1/4 (0.25) score in C 1.3 and C 1.4 respectively. Furthermore, series 1 has no paper folding and reflection on geometric and non-geometric shapes to determine line symmetry in C 2.2, resulting in a zero score. Neither does it request learners to copy and extend geometric patterns made with drawings of lines, shapes or objects in C 3.1 - 3.3 and C 3.6. Learners have no geometric patterns all around us to copy in C 4.2. The overall score is 10.50 less than the maximum possible score for the skill, which is at 42% CAPS compliance level.

Series 2 has no activity to draw any circles and rectangles in C 1.1 and C 1.4, respectively. The instructions for learners to draw a triangle and a square are without specification of how many should be drawn, sizes or even positions of the drawings; thus, there is no guarantee of all shapes of triangle and sizes and positions being represented, hence the assumption made by the researcher is of the drawing of one triangle and one square, each with one size and one position in C 1.2 i - iii and C 1.3. Furthermore, there is no paper folding and reflection on geometric and non-geometric shapes in C 2.2, neither is there any copying and extending geometric patterns made with drawings of lines, shapes or objects in C 3.1 - 3.3. The overall score is 9.00 less than the maximum possible for the skill and a 50% CAPS compliance.

Series 3 also does not have an activity for learners to draw a circle in C 1.1. There is only one specific instruction to copy one scalene triangle, with one size and position in C 1.2iii, but none to draw or copy an equilateral in C 1.2i or isosceles triangles in C 1.2ii. Furthermore, there is only one square of one size and position drawn/copied and similarly, only one rectangle of one size and position drawn / copied in C 1.3 and C 1.4 respectively. There is no evidence of paper folding and reflection on geometric and non-geometric shapes and no copying and / or extending of geometric patterns in C 3.2 and C 4.3. The overall score of 10.50 is 7.50 less than the maximum possible for the skill and a 58% CAPS compliance.

Series 4 provides for the tracing of two different sizes of equilateral triangles, but fails to provide different positions, hence the loss of a score of 1/4 (0.25) in C 1.2i. The series has no paper folding and reflection on geometric and / or non-geometric shapes in C 2.2, hence the zero score in this regard. It also lacks the copying extension of geometric patterns in C 3.1 and C 3.2, as well as copying of geometric patters from nature and our cultural heritage in C 4.1 and C 4.3. The overall score of 12.75 is the best for a series in the skill, even if it is 5.25 less than the maximum possible score only at 71% CAPS compliance level.

Series 5 also neglects to include an instruction on drawing or copying a circle and thus lacks the same instruction on two circles of different sizes in C 1.1. It only provides instruction for a right-angled scalene triangle in one size and position, but lacks activities to draw the other types of different triangles in C 1.2i and C 1.2ii. It lacks a different position for the two squares drawn with different sizes in C 1.3, hence the loss of a 1/4 (0.25) score; there is no paper folding and reflection on geometric and / or non-geometric shapes in C 2.2. It lacks the copying and extension of geometric patterns in C 3.2 and C 3.3, as well as the copying of patterns from nature and cultural heritage in C 4.1 and C 4.3. The overall score of 9.75 is 8.75 less than the maximum possible score for the skill and at 51% CAPS compliance level.

4.4.1.1.4 Logical skills score *(Possible: 3.00)*

The following are the results of the evaluation based on Appendix B and the specific teaching-learning activities D 1.1 - 1.3. The abbreviated version of these results is section D of Table 4.4 above and the full version is in Appendix B. The evaluation revealed that all the teaching-learning activities not allocated a perfect score of 1 lacked the logical skills of the 2-D shapes as given below.

Series 1 - 5 provide activities for learners to sort and compare shapes according to the number of straight sides and thereby comply with D 1.1 – 1.3, thus scoring full allocations. All five series are thus at 100% CAPS compliance level on the logical skill.

4.4.1.1.5 Applied skills score *(Possible: 5.00)*

The following are the results of the evaluation based on Appendix B and the specific teaching-learning activities E 1.1 - 1.2 and E 2.1 - 2.3. The abbreviated version of these results is section E of Table 4.4 above and the full version is in Appendix B. The evaluation revealed that all the teaching-learning activities not allocated a perfect score of 1 lacked the applied skills of the 2-D shapes as given below.

Series 1 has no identification of patterns in modern everyday life and our cultural heritage in E 2.2 and 2.3, thus scores of zero for each, for an overall score of 3.00 which is 2.00 less than the maximum possible score for the skill. This is a 60% CAPS compliance level.

Series 2 has no activity for learners to identify patterns all around us in nature, modern everyday life and our cultural heritage in E 2.1 - 2.3, thus earned zero scores in all three cases. Its overall score of 2.00 is 3.00 less than the maximum possible score for the skill.
Series 3 has no activities for learners to create own geometric patterns with physical objects in E 1.1 and similarly lacks a request for learners to identify patterns all around us in nature and our cultural heritage in E 2.1 and E 2.3. For the lack of compliance in all three cases, the series earned zero scores, resulting in an overall score of 2.00, which is 3.00 less than the maximum possible score for the skill and a 40% CAPS compliance level.

Series 4, just like series 2 has no request for learners to identify patterns all around us in nature, modern everyday life and our cultural heritage in E 2.1 - 2.3. For this lack of compliance, it earned zero scores in all three cases. The overall score of 2.00 is 3.00 less than the maximum score for the skill and a 40% compliance with the CAPS.

Series 5, similar to series 1, has no identification of patterns in modern everyday life and our cultural heritage in E 2.2 and E 2.3, thus scores of zero for each, and an overall score of 3.00, which is 2.00 less than the maximum score for the skill. This is a 60% CAPS compliance level for the series.

4.4.1.2 Grade 4 textbooks' CAPS compliance

The evaluation of the grade 4 Mathematics textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes is specifically based on the properties, relationships, orientations, positions and transformations of 2-D shapes. The learners' experience in the intermediate phase grades 4 - 6 moves from recognition and simple description to classification and more detailed description of characteristics and properties of 2-D shapes (DBE, 2011b: 6). The learner is also given opportunities to draw

2-D shapes further, describe locations (positions), transformation and symmetry (DBE, 2011b: 6).

Appendix C provides the full extent of results of the evaluation of the five grade 4 series of textbooks on the CAPS-based teaching-learning activities and their corresponding five geometric skills on the Mathematics topics, concepts and skills of grade 4. Table 4.5 below in this section 4.4.1.2, is a shortened version of Appendix C. It is divided into two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 4 series of textbooks' coding and scores allocated to each textbook during the evaluation. As represented in the CAPS-based measuring tool in Appendix C, the five geometric skills are underpinned by the teaching-learning activities that should be provided to learners in the textbooks. The five grade 4 textbooks are designated S 1, S 2, S 3, S 4 or S 5, where S is an abbreviation of the word "series".

The scores obtained by each grade 4 textbook of the series during the evaluation are listed under the grade 4 textbook's series designation to correspond with each skill in Table 4.5 and with both the specific skill and teaching-learning activity in Appendix C. In both Appendix C and Table 4.5, the scores and total scores of each grade 4 textbook of the series have been entered side by side in columns for comparison with one another and the possible maximum scores on the specific skill. The total scores of each grade 4 series textbook are provided at the bottom of each column of the grade 4 textbook scores and can also be compared with one another and with the possible maximum total score for the five geometric skills. An account of why each geometric skill in Table 4.5, based on its component teaching-learning activities, has not obtained a perfect score follows the table in the same order that the skills and results are presented in the table and the relevant Appendix C. The amount of score by which each skill has come short of the possible maximum perfect score depends on the score(s) of the individual teaching-learning activities in Appendix C that were either partially or completely not complied with by the textbook contents as expected by the CAPS.

The specific teaching-learning activities in Appendix C which are not fully complied with by the textbooks, as indicated by a partial or a zero score instead of a full score of 1 are also named as part of giving the results of every skill for every series of textbook, but also as identifying how the lack of compliance resulted; can be verified and then corrected. The numbers of aspects for full compliance by textbooks have been included in brackets or written in italics in Appendix C, in the relevant teaching-learning activity.

Table 4.5: Grade 4 textbook series' percentage CAPS compliance

GEOMETRIC SKILLS	Grade 4 series coding and scores (raw and %)				
	S 1	S 2	S 3	S 4	S 5
A. Visual Skills Score : 9.00	8.40 (93%)	8.22 (91%)	8.00 (89%)	8.40 (93%)	7.73 (86%)
B. Verbal / Written Skills Score: 16.00	16.00 (100%)	15.75 (98%)	14.93 (93%)	13.17 (82%)	13.75 (86%)
C. Drawing Skills Score : 9.00	7.50 (83%)	8.25 (92%)	8.50 (94%)	8.00 (89%)	8.75 (97%)
D. Logical Skills Score : 5.00	5.00 (100%)	5.00 (100%)	3.00 (60%)	2.00 (40%)	4.00 (80%)
E. Applied Skills Score : 2.00	2.00 (100%)	2.00 (100%)	2.00 (100%)	2.00 (100%)	2.00 (100%)
TOTAL SCORES : 41.00	38.90**(95%)**	39.22**(96%)**	36.43**(89%)**	33.57**(82%)**	36.23 **(88%)**

4.4.1.2.1 Visual skills score *(Possible: 9.00)*

The following are the results of the evaluation based on Appendix C and the specific teaching-learning activities A 1.1 - 1.9. The abbreviated version of these results is section A of Table 4.5 above and the full version is in Appendix C. All the teaching-learning activities not allocated a perfect score of 1 lacked the visual skills of the 2-D shapes as given below.

Series 1 lacks recognition of 2-D shapes, without line symmetry, with double and triple lines of symmetry as part of compliance aspects of teaching-learning activity A 1.7. The three lacking aspects represent 3/5 (0.60) of a whole, hence, a total score of 8.40 instead of the perfect score of 9.00. The corresponding CAPS compliance level is 93%.

Series 2 lacks the recognition of right-angled triangle(s), kite(s) and the multiple line symmetries as part of compliance aspects of teaching-learning activities A 1.2, 1.3 and 1.7 respectively. The different lacking aspects represent 1/6 (0.17), 1/6 (0.17) and 1/5 (0.20) respectively, for a total of 1.58 which is exactly the amount needed for series 2 to make the possible maximum total score of 9.00 on the visual skill. This represents a 91% CAPS compliance level.

Series 3 lacks the recognition of equilateral, scalene and obtuse angled triangles, as part of compliance aspects of the teaching-leaning activity A 1.2 and A 1.5. The lacking aspects represent 3/6 (0.50) and 1/4 (0.25) respectively needed for series 3 to make the possible maximum total score of 9.00.The corresponding CAPS compliance is 89%.

Series 4 lacks the recognition of 2-D shape(s) without line symmetry, with three line symmetries as well as multiple symmetries as part of the compliance of teaching-learning activities of A 1.7. These lacking aspects represent 3/5 (0.60) by which the series is lacking to make the possible maximum total score of 9.00. Its CAPS compliance level is 93%.

Series 5 lacks the recognition of equilateral triangle(s) and 2-D shapes without line symmetry, single and double line of symmetries. As part of the compliance aspects of teaching-learning activities A 1.2, A 1.5 and A 1.7, and representing 1/6 (0.17), 1/4 (0.25) and 3/5 (0.60), respectively, they form the 0.77 score lacking for series 5 to obtain a perfect total score of 9.0. The CAPS compliance level is 86%.

4.4.1.2.2 Verbal / written skills score *(Possible: 16.00)*

The following are the results of the evaluation based on Appendix C and the specific teaching-learning activities B 1.1 - 1.5, B 2.1 - 2.3 and B 3.1 - 3.8. The abbreviated version of these results is section B of Table 4.5 above, and the full version is in Appendix C. All the teaching-learning activities not allocated a perfect score of 1 lacked the verbal / written skills of the 2-D shapes as given below.

Series 1 lacks none of the compliance aspects of the teaching-learning activities in the measuring instrument, hence obtains the perfect total score of 16.00 demonstrating a 100% CAPS compliance level.

Series 2 lacks the identification and naming of the rhombus by the group name quadrilateral in B 2.3, leading to a score of 1/4 (0.25) less. Its corresponding CAPS compliance level is 98%.

Series 3 lacks exercise(s) describing triple and multiple (more than triple) lines of symmetry in teaching-learning activity B 1.5, leading to a score 2/5 (0.40) less. In contradiction to teaching-learning activity B 2.3, series 3 uses the individual names of two of the other quadrilaterals, instead of the group name, thereby acquiring a score 2/4 (0.50) less. As a result of the lack of compliance named above, series 3 is 0.90 scores below the maximum total score, 93% compliant with the CAPS on this specific skill.

Series 4 lacks activities that include the description and naming of parallelograms and rhombus as quadrilaterals for compliance with B 1.3 and B 2.3, thus the scores of 2/6 (0.33) and 2/4 (0.50) less, respectively. The lack of compliance has resulted in series 4 being 2.83 scores below the maximum total score of 16.00 and at 82% CAPS compliance.

Series 5 lacks the instruction(s) requiring learners to name a rhombus as a quadrilateral in B 2.3. Furthermore, it lacks the identification and description of patterns in nature and pattern from our cultural heritage in B 3.4 and B 3.6, respectively. The lacking aspects amount to a

2.25 score below the maximum total score for verbal / written skills' score for the series and thus 86% CAPS compliant.

4.4.1.2.3 Drawing skills score *(Possible: 9.00)*

The following are the results of the evaluation based on Appendix C and the specific teaching-learning activities C 1.1 - 1.3, C 2.1 - 2.4, C 3.1 and C 4.1. The abbreviated version of these results is section C of Table 4.5 above and the full version is in Appendix C. All the teaching-learning activities not allocated a perfect score of 1 lacked the drawing of the 2-D shapes as given below.

Series 1 neglects to include activities on drawing 2-D shapes with no symmetries and specifically on the grid as part of C 1.1, and also neglects instruction about copying and / or extending simple repeating patterns in C 2.1. Lack of compliance on the two teaching-learning activities result in scores of 2/4 (0.50) less and zero respectively, with a 1.50 score below the maximum total score for the skill. The overall CAPS compliance is 83%.

Series 2 neglects using the grid for drawing multiple symmetries on for C 1.1, as well as the line symmetry in composite shapes for C 4.1, resulting in accumulating 1/4 (0.25) and 1/2 (0.50) less scores and a total of 3/4 (0.75) less than the maximum total score for the skill. Its overall CAPS compliance is 92%.

Series 3 neglects the line symmetry in composite shapes for C 4.1, resulting in a 1/2 (0.50) less score and a total which is the same score less than the maximum total score for the skill. This result is a 94% CAPS compliance level.

Series 4 neglects activities about drawing on the grid and drawing shape(s) with no line of symmetry for C 1.1, thus the score of 2/4 (0.50) less than the possible maximum. It also neglects the line of symmetry in tessellated patterns for C 3.1, thus scoring 1/2 (0.50) less. The two incidents of non-compliance in C 1.1 and C 3.1 lead to a series score which is 1.00 less than the maximum total score, representing an 89% CAPS compliance level.

Series 5 neglects the symmetries of shapes drawn on the grid in C 1.1, resulting in a 1/4 (0.25) less score and a skills score which is as much less that the maximum total score. This represents a 97% compliance with the CAPS.

4.4.1.2.4 Logical skills score *(Possible: 5.00)*

The following are the results of the evaluation based on Appendix C and the specific teaching-learning activities D 1.1 - 1.5. The abbreviated version of these results is section D of Table 4.5 above and the full version is in Appendix C. All the teaching-learning activities not allocated a perfect score of 1 lacked the logical skills of the 2-D shapes as given below.

Series 1 has implemented all teaching-learning activities of D 1.1 - 1.5, and is thus fully compliant at 100% with regard to the aspects involved therein.

Series 2, similar to series 1 above, has implemented all teaching-learning activities of D 1.1 - 1.5, and is thus fully compliant at 100% with regard to the aspects involved therein.

Series 3 does not use the terms regular or irregular at all or any equivalents, and totally neglects the related sorting and comparison in D 1.4 and 1.5, which leads to zero scores in both teaching-learning activities and a total skills score of 3.00. It is 60% CAPS compliant.

Series 4, similar to series 3, does not refer to regular and irregular shapes at all in D 1.4 and 1.5, and has zero scores in both. It only sorts shapes according to the same number of straight sides and common names, triangles, quadrilateral, pentagons and hexagon, but neglects any comparison between two triangles, pentagons or hexagons according to lengths of sides or sizes of angles. Its total score of 3.00 represents a 40% CAPS compliance.

Series 5 only compares pentagons and hexagons, neglecting the triangles and quadrilaterals in D 1.4 and D 1.5, resulting in the score of 1/2 (0.50) less in both teaching-learning activities. The series' total score is thus 1.00 less than the maximum total score for the skill and an 80% CAPS compliance level.

4.4.1.2.5 Applied skills score (Possible: 2.00)

The following are the results of the evaluation based on Appendix C and the specific teaching-learning activities E 1.1 - 1.2. The abbreviated version of these results is section E of Table 4.5 above and the full version is in Appendix C.

All textbooks of series 1 - 5 are fully compliant with the teaching-learning activities E 1.1 and E 1.2, hence they all scored the maximum total score for the skill and achieve a 100% CAPS compliance level.

4.4.1.3 Grade 5 textbooks' CAPS compliance

Similar to the grade 4 textbooks, the evaluation of the grade 5 Mathematics textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes is specifically based on the properties, relationships, orientations, positions and transformations of 2-D shapes. The learner's experience in the intermediate phase grades 4 - 6 moves from recognition and simple description to classification and more detailed description of characteristics and properties of 2-D shapes (DBE, 2011b: 6). The learner is also given opportunities to draw 2-D shapes further, describe locations (positions), transformation and symmetry (DBE, 2011b: 6).

Appendix D provides the full extent of results of the evaluation of the five grade 5 series of textbooks on the CAPS-based teaching-learning activities and their corresponding five geometric skills on the Mathematics topics, concepts and skills of grade 5. Table 4.6 below in this section 4.4.4.3, is a shortened version of Appendix D. It is divided into two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 5 series of textbooks' coding and scores allocated to each textbook during the evaluation. As represented in the CAPS-based measuring tool in Appendix D, the five geometric skills are underpinned by the teaching-learning activities that should be provided to learners in the textbooks. The five grade 5 textbooks evaluated are designated S 1, S 2, S 3, S 4 or S 5, where S is an abbreviation of the word "series".

The scores obtained by each grade 5 textbook of the series during the evaluation are listed under the grade 5 textbook's series designation to correspond with each skill in Table 4.6 and with both the specific skill and teaching-learning activity in Appendix D. In both Appendix D and Table 4.6, the scores and total scores of each grade 5 textbook of the series have been entered side by side in columns for comparison with one another and the possible maximum perfect scores on the specific skill. The total scores of each grade 5 series textbook is provided at the bottom of each column of the grade 5 textbook scores and can also be compared with one another and with the possible maximum total score for the five geometric skills. An account of why each geometric skill in Table 4.6, based on its component teaching-learning activities, has not obtained a perfect score, follows the table in the same order that the skills and results are presented in the table and relevant Appendix D. The amount of score by which each skill has come short of the possible maximum perfect score depends on the scores of the individual teaching-learning activities in Appendix D that were either partially or completely not complied with by the textbook contents as expected by the CAPS.

The specific teaching-learning activities in Appendix D which are not fully complied with by the textbooks, as indicated by a partial or a zero score instead of a full score of 1, are also named as part of giving the results of every skill for every series of textbook, but also as identifying how the lack of compliance resulted; can be verified and then corrected. Where possible, the numbers of aspects for full compliance by textbooks have been included in brackets or written in italics in Appendix D, in the relevant teaching-learning activity.

Table 4.6: Grade 5 textbook series' percentage CAPS compliance

GEOMETRIC SKILLS	Grade 5 series coding and scores (raw and %)				
	S1	S 2	S 3	S 4	S 5
A. Visual Skills Score : 14.00	13.80 (99%)	13.80 (99%)	14.00 (100%)	14.00 (100%)	13.43 (96%)
B. Verbal / Written Skills Score : 20.00	19.10 (96%)	16.37 (82%)	17.72 (89%)	19.00 (95%)	15.72 (79%)
C. Drawing Skills Score : 11.00	9.67 (88%)	10.67 (97%)	10.17 (92%)	10.17 (92%)	7.67 (70%)
D. Logical Skills Score : 5.00	4.90 (98%)	5.00 (100%)	5.00 (100%)	5.00 (100%)	4.40 (88%)
E. Applied Skills Score : 2.00	2.00 (100%)	2.00 (100%)	2.00 (100%)	2.00 (100%)	2.00 (100%)
TOTAL SCORES : 52.00	49.47 (**95%**)	47.84**(92%)**	48.89**(94%)**	50.17 **(96%)**	43.22 **(83%)**

4.4.1.3.1 Visual skills score *(Possible: 14.00)*

Hereafter follow the results of the evaluation based on Appendix D and the specific teaching-learning activities A 1.1 - 1.12 and A 2.1 - 2.2. The abbreviated version of these results is section A of Table 4.6 above and the full version is in Appendix D. All the teaching-learning activities not allocated a perfect score of 1 lacked the visual skills of the 2-D shapes as given below.

Series 1 lacks the recognition of an irregular pentagon, which is particularly important for A 1.7, thereby losing a 1/5 (0.20) score. Its overall score is thus 0.20 less than the possible maximum for the skill and is a 99% compliance with the CAPS for the skills.

Series 2 lacks the recognition of a 2-D shape without line symmetry, hence a loss of a 1/5 (0.20) score in A 1.9, resulting in an overall skill's score which is 0.20 less than the possible maximum for the skill at 13.80. This represents a 99% compliance with the CAPS for the skills.

Series 3 and 4 are fully compliant with all the teaching-learning activities A 1.1 - A 1.12 and A 2.1 - 2.2 hence, the full score of 14.0 for both the skills. This full score represents a 100% compliance of the series with the CAPS on visual skills.

Series 5 lacks the recognition of a rhombus in its range of different quadrilateral for A 1.3 and also lacks the regular triangle (equilateral) and heptagon in its range of regular polygons for

A 1.6. As a result, series 5 has scores that are 1/6 (0.17) and 2/5 (0.40) less for the respective teaching-learning activities named, and a total of 0.57 less than the possible maximum for the skill for the total score. The total score demonstrates a 96% compliance with the CAPS.

4.4.1.3.2 Verbal / written skills score *(Possible: 20.00)*

Hereafter follow the results of the evaluation based on Appendix D and the specific teaching-learning activities B 1.1 - 1.6; B 2.1 - 2.6; B 3.1 - 3.5 and B 4.1 - 4.3. The abbreviated version of these results is section B of Table 4.6 above and the full version is in Appendix D. All the teaching-learning activities not allocated a perfect score of 1 lacked the verbal / written skills of the 2-D shapes as given below.

Series 1 lacks the naming of a regular heptagon, an irregular pentagon, a rhombus and a kite as part of the aspects of B 1.1, B 1.2 and B 1.4 respectively; hence, the losses of 1/5 (0.20), 1/5 (0.20) and 2/4 (0.50) scores respectively for the teaching-learning activities. Its total score of 19.10 represents a 96% compliance with these CAPS on the skills.

Series 2 lacks a regular triangle to identify by group name in B 1.1, thus a loss of a 1/5 (0.20) score; lacks the identification of irregular pentagon, hexagon and heptagons in B 1.2, resulting in a 3/5 (0.60) less score; lacks the identification of the parallelogram and rhombus by the group name in B 1.4, hence, a 2/4 (0.50) less score; lacks identification of zero line of symmetry in B 2.2, thereby losing a 1/3 (0.33) score and has no identification of angles smaller and greater than a right angle in B 2.5 and B 2.6, for a loss of 1 point score each. Series 2 scored 3.63 below the possible maximum score for these skills, thus achieving a compliance level of 82% with the CAPS.

Series 3 lacks a regular triangle to identify by the group name in B 1.1, a loss of 1/5 (0.20) score; lacks to identify the rhombus, kite and trapezium by the group name in B 1.4, hence, a 3/4 (0.75) less score, and lacks to identify shapes with zero line of symmetry in B 2.2, thereby losing a 1/3 (0.33) score. It has no description of patterns from our cultural heritage in B 4.3, thus obtaining a zero score. Series 3 scored 2.28 below the possible maximum score for this skill, an 89% CAPS compliance level for the skills.

Series 4 has no identification of a shape with zero line of symmetry in B 2.2, but asks if there is any shape with zero line of symmetry to make the reader aware that it is possible. Its total score of 19.00 is a 95% compliance with the CAPS for the skills.

Series 5 lacks a regular triangle to identify by the group name in B 1.1, thus scoring 1/5 (0.20) less; lacks a question to identify a circle by name in B 1.3, hence a zero score; lacks a rhombus to identify by the group name quadrilateral in B 1.4, thus a 1/4 (0.25) less score; neglects to describe shapes in terms of the angles smaller and greater than right angle in B 3.4, thereby losing a 2/3 (0.67) score and has no description of patterns in nature and from our cultural heritage in B 4.1 and B 4.3 respectively, thus obtaining zero scores in each. Series 5 scored 4.28 below the possible maximum score for these skills, a 79% compliance with CAPS.

4.4.1.3.3 Drawing skills score *(Possible: 11.00)*

Hereafter follow the results of the evaluation based on Appendix D and the specific teaching-learning activities C 1.1 - 1.3; C 2.1 - 2.4; C 3.1 - 3.2 and C 4.1 - 4.2. The abbreviated version of these results is section C of Table 4.6 above and the full version is in Appendix D. All the teaching-learning activities not allocated a perfect score of 1 lacked the drawing skills of the 2-D shapes as given below.

Series 1 lacks activities to draw the line(s) of symmetry on the square and rectangle drawn on the grid to demonstrate the multiple lines of symmetry, including diagonal and horizontal lines of symmetry in C 1.1, hence the loss of a 1/3 (0.33) score. It has no simple repeating patterns for C 2.1, resulting in a zero score and an overall skills score 1.33 less than the maximum possible total score 11.00. This is an 88% compliance with CAPS.

Series 2 lacks an instruction to draw a 2-D shape with zero line of symmetry in C 1.1, thus the loss of a 1/3 (0.33) score and a compliance of 97% with CAPS.

Series 3 lacks a 2-D shape drawing on the grid with zero line of symmetry in C 1.1, thus losing a 1/3 (0.33). It also lacks an activity about the indication of the line(s) of symmetry in composite shapes in C 4.2, resulting in a loss of 1/2 (0.50) score. It has an overall score of 10.17, which is 0.83 less than the maximum possible total score of the skills, and a 92% compliance with CAPS.

Series 4 lacks an activity of a drawing with zero line of symmetry on the grid as part of C 1.1, leading to a loss of a 1/3 (0.33) score, and has no instruction about drawing the line(s) of symmetry of the composite shapes as part of C 4.2, thus scoring 1/2 (0.50) less. It is overall 0.83 less than the maximum possible total score of 11.00 and achieves a 92% compliance level with the CAPS.

Series 5 lacks an activity of a drawing with zero line of symmetry on the grid for C 1.1, thus losing a 1/3 (0.33) score. It lacks activities on completing simple repeating patterns in C 2.1, hence the zero score; lacks activity (-ies) about drawing the line(s) of symmetry of both tessellated patterns and composite shapes in C 3.2 and C 4.2, leading to zero score in both cases. It has an overall skills score of 7.67, which is 3.3 less than the maximum possible total score of 11.00 for the skill, and thus a 70% compliance with the CAPS.

4.4.1.3.4 Logical skills score *(Possible: 5.00)*

Hereafter follow the results of the evaluation based on Appendix D and the specific teaching-learning activities D 1.1 - 1.5. The abbreviated version of these results is section D of Table 4.6 above and the full version is in Appendix D.

Series 1 - 5 have all complied with the all the teaching-learning activities D 1.1 - 1.5, leading to all five series acquiring the maximum possible total scores of 5.0.

4.4.1.3.5 Applied skills score (Possible: 2.00)

Hereafter follows the results of the evaluation based on Appendix D and the specific teaching-learning activities E 1.1 - 1.2. The abbreviated version of these results is section E of Table 4.6 above and the full version is in Appendix D.

Series 1 - 5 have all complied with all the teaching-learning activities E 1.1 - 1.2, leading to all five series acquiring the maximum possible total scores of 2.00 and consequently 100% compliance with the CAPS.

4.4.1.4 Grade 6 textbooks CAPS' compliance

Similar to the grade 4 and 5 textbooks, the evaluation of the grade 6 Mathematics textbooks on their contribution toward the development of the conceptual understanding of 2-D shapes is specifically based on the properties, relationships, orientations, positions and transformations of 2-D shapes. The learners' experience in the intermediate phase grades 4 - 6 moves from recognition and simple description to classification and more detailed description of characteristics and properties of 2-D shapes (DBE, 2011b: 6). The learner is also given opportunities to draw 2-D shapes further, describe locations (positions), transformation and symmetry (DBE, 2011b: 6).

Appendix E provides the full extent of results of the evaluation of the five grade 6 series of textbooks on the CAPS-based teaching-learning activities and their corresponding five geometric skills on the Mathematics topics, concepts and skills of grade 6. Table 4.7 below in

this section 4.4.4.4, is a shortened version of Appendix E. It is divided into two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 6 series of textbooks' coding and scores allocated to each textbook during the evaluation. As represented in the CAPS-based measuring tool in Appendix E, the five geometric skills are underpinned by the teaching-learning activities that should be provided to learners in the textbooks. The five grade 6 textbooks evaluated are designated S 1, S 2, S 3, S 4 or S 5, where S is an abbreviation of the word "series".

The scores obtained by each grade 6 textbook of the series during the evaluation are listed under the grade 6 textbooks series designation to correspond with each skill in Table 4.7 and with both the specific skill and teaching-learning activity in Appendix E. In both Appendix E and Table 4.7, the scores and total scores of each grade 6 textbook of the series have been entered side by side in columns for comparison with one another and the possible maximum perfect scores on the specific skill. The total score of each grade 6 series textbook is provided at the bottom of each column of the grade 6 textbook scores and can also be compared with one another and with the possible maximum total score for the five geometric skills. An account of why each geometric skill in Table 4.7, based on its component teaching-learning activities, has not obtained a perfect score follows the table in the same order that the skills and results are presented in the table and relevant Appendix E. The amount of score by which each skill has come short of the possible maximum perfect score depends on the scores of the individual teaching-learning activities in Appendix E that were either partially or completely not complied with by the textbook contents as expected by the CAPS.

The specific teaching-learning activities in Appendix E which are not fully complied with by the textbooks, as indicated by a partial or a zero score instead of a full score of 1.00, are also named as part of giving the results of every skill for every series of textbook, but also as identifying how the lack of compliance resulted; can be verified and then corrected. The numbers of aspects for full compliance by textbooks have been included in brackets or written in italics in Appendix E, in the relevant teaching-learning activity.

Table 4.7: Grade 6 textbook series' percentage CAPS compliance

GEOMETRIC SKILLS	**Grade 6 series coding and scores (raw and %)**				
	S 1	**S 2**	**S 3**	**S 4**	**S 5**
A. Visual Skills Score **:** 14.00	13.33 (95%)	13.83 (99%)	14.00 (100%)	14.00 (100%)	13.83(99%)
B. Verbal / Written Skills Score**:** 17.00	15.25 (90%)	12.83 (75%)	12.50(74%)	15.50 (91%)	12.33 (73%)
C. Drawing Skills Score **:** 9.00	8.00 (89%)	9.00 (100%)	9.00 (100%)	9.00 (100%)	8.00 (89%)
D. Logical Skills Score **:** 5.00	3.67 (73%)	5.00 (100%)	2.00 (40%)	4.00 (80%)	3.17 (63%)
E. Applied Skills Score **:** 2.00	2.00 (100%)	2.00 (100%)	2.00 (100%)	2.00 (100%)	2.00 (100%)
TOTAL SCORES : 47.00	42.25 **(90%)**	42.66 **(91%)**	39.50 **(84%)**	44.50 **(95%)**	39.33 **(84%)**

4.4.1.4.1 Visual skills score *(Possible: 14.00)*

Hereafter follow the results of the evaluation based on Appendix E and the specific teaching-learning activities A 1.1 - 1.12 and A 2.1 - 2.2. The abbreviated version of these results is section A of Table 4.7 above and the full version is in Appendix E. All the teaching-learning activities not allocated a perfect score of 1 lacked the visual skills of the 2-D shapes as given below.

Series 1 lacks other non-polygons for recognition besides the circle which is the only one it has, thus losing a score 1/2 (0.50) for partial compliance with respect to A 1.2. Furthermore, series 1 lacks the rhombus as one of the six quadrilaterals to be recognised in A 1.3, thereby losing a 1/6 (0.17) score. Its overall score is 0.67 less than the maximum total possible score for the skills. It is 95% compliant with the CAPS.

Series 2 lacks the recognition of a rhombus as one of the quadrilaterals in A 1.3, thus losing a 1/6 (0.17) score, with total skill's score of 13.83. This represents a 99% compliance with the CAPS for the skills.

Series 3 has a perfect total score of 14.00 for being fully compliant with all the teaching-learning activities of the visual skills.

Series 4, similar to series 3 above, has a perfect total score of 14.00 for being fully compliant with all the teaching-learning activities of the visual skills.

Series 5 lacks an irregular heptagon for recognition in A1.10, thus losing a 1/6 (0.17) score. The result is a 99% compliance with the CAPS.

4.4.1.4.2 Verbal / written skills score *(Possible: 17.00)*

Hereafter follow the results of the evaluation based on Appendix E and the specific teaching-learning activities B 1.1 - 1.7; B 2.1 - 2.3; B 3.1 - 3.4 and B 4.1 - 4.3. The abbreviated version of these results is section B of Table 4.7 above and the full version is in Appendix E. All the teaching-learning activities not allocated a perfect score of 1 lacked the verbal / written skills of the 2-D shapes as given below.

Series 1 lacks a regular heptagon to identify in B 1.2 and an irregular pentagon and a heptagon for identification by name in B 1.3. Furthermore, it has no non-polygons except the circle to identify by name in B 1.4 and a rhombus not included as a quadrilateral in B 3.4. In

total, lost 1/6 (0.17), 2/6 (0.33), 3/4 (0.75), 2/6 (0.33) and 1/6 (0.17) for a total score of 15.25 which is 1.75 less than the total possible maximum score and a compliance of 90%

Series 2 lacks the identification of the straight angle and revolution in shapes or by themselves in B 1.1, thereby losing 2/6 (0.33) score and has no description of patterns in nature, modern everyday life or cultural heritage in B 4.1 - 4.3; hence, zero scores in this regard. The reflex and revolution angles are not covered for identification and description in B 3.3, thus a further loss of 2/6 (0.33) and a total of 12.83 from possible total maximum score of 17.00. Compliance level is at 75%.

Series 3 lacks the identification of the rhombus and trapezium by the group name quadrilateral in B 1.5, hence the loss of a 2/3 (0.67) score. Its 2-D shapes lack revolution, reflex and straight angles for description in B 3.3, losing 3/6 (0.50) score; does not request learners to identify and describe a rhombus and trapeziums as quadrilaterals, thereby losing 2/6 (0.33) in B 3.4. Furthermore, it has no activity for the description of patterns in nature, modern everyday life or cultural heritage in B 4.1 – B 4.3, thereby scoring zero in all three cases. Its total score of 12.50 is 4.50 less and has a compliance level of 74%.

Series 4 shapes lack the revolution, reflex and straight angles for description in B 3.3, scoring 3/6 (0.50) less and has no description of patterns in nature in B 4.1 for compliance. Its total score of 15.50 is 1.50 less than the possible maximum total scores of 17.00, representing a 91% compliance with the CAPS.

Series 5 shapes lack identification of the revolution, reflex and straight angles in B 1.1, thus scoring 3/6 (0.50) less; lacks an irregular heptagon for identification in B 1.3, thereby scoring 1/6 (0.17) less and have no description of patterns in nature, modern everyday life or cultural heritage for B 4.1 - 4.3. Its total score of 12.33 is a score of 4.67 less than the maximum possible score, giving a compliance level of 73%.

4.4.1.4.3 Drawing skills score *(Possible: 9.00)*

Hereafter follow the results of the evaluation based on Appendix E and the specific teaching-learning activities C 1.1 - 1.5 and C 2.1 - 2.4. The abbreviated version of these results is section C of Table 4.7 above and the full version is in Appendix E. All the teaching-learning activities not allocated a perfect score of 1 lacked the drawing skills of the 2-D shapes as given below.

Series 1 and 5 lack the simple repeating pattern(s) to extend for compliance with C 2.1, hence both have a total score of 8.00, which is 1.00 less than the total possible score of 9.00. Their compliance is at 89% level with the CAPS.

Series 2, 3 and 4 are completely compliant with regard to the teaching-learning activities of the drawing skills, hence C 1.1 - 1.5 and C 2.1 - 2.4 have been scored with the possible maximum scores of 1.00. The three series are thus 100% compliant in this regard.

4.4.1.4.4 Logical skills score *(Possible: 5.00)*

Hereafter follow the results of the evaluation based on Appendix E and the specific teaching-learning activities D 1.1 - 1.5. The abbreviated version of these results is section D of Table 4.7 above and the full version is in Appendix E. All the teaching-learning activities not allocated a perfect score of 1 lacked the logical skills of the 2-D shapes as given below.

Series 1 neglects to identify any other non-polygons, except the circle by drawing, name or even comparison to comply with D 1.2, thus scores 1/2 (0.50) less. Furthermore, it lacks activities involving regular pentagons and octagons for compliance with D 1.3 as well as activities involving irregular pentagons to be fully compliant with D 1.4, thus losing a score 5/12 (0.42) in each. The total score of 3.67 falls short of the total maximum possible by 1.33 and is a 73% compliance with the CAPS.

Series 2 is fully compliant with all the D 1.1 - 1.5 teaching-learning activities, and thus scores the maximum for all of them, thus a 100% compliance with the CAPS.

Series 3 has no activities to sort and compare regular and irregular polygons in terms of lengths of sides as well as sizes of angles in D 1.3 and D 1.4 respectively, thus entirely not compliant. It similarly has no activities requiring the sorting and comparing of sizes of shapes transformed through enlargement / reduction to comply with D 1.5, and thus has the lowest total score of 2.0 from the maximum total possible score of 5.00 for the skills. Its compliance with the CAPS is thus 40%.

Series 4 has no sorting of shapes according to equal and / or unequal angles for D 1.4 and thus has a total score of 1.00 less than the maximum total score of 5.00 for the skills. Its consequent compliance with the CAPS is at the 80% level.

Series 5 is only compliant with respect to comparing regular and irregular triangles according to lengths of sides in D 1.3 and neglects to do the same for quadrilaterals up to octagons,

thus losing a 10/12 (0.83) score. It is entirely non-compliant with respect to comparing regular and irregular polygons according to angles in D 1.4, ending with the second lowest score of 3.17 for the skills and a 63% CAPS compliance level.

4.4.1.4.5 Applied skills score *(Possible: 2.00)*

Hereafter follow the results of the evaluation based on Appendix E and the specific teaching-learning activities E 1.1 - 1.2. The abbreviated version of these results is section E of Table 4.7 above and the full version is in Appendix E.

Series 1 up to series 5 are all fully compliant with respect to applied skills in teaching-learning activities E 1.1 and E 1.2 regarding investigation and extension of patters. All textbook series scored the possible maximum perfect scores and are thus 100% complaint with regard to these skills.

4.4.1.5 Grade 6 textbooks' progression compliance to grade 7

Similar to the grade 4 and 5 textbooks, the evaluation of the grade 6 Mathematics textbooks on their contribution toward the development of the conceptual understanding of 2-D shapes is still based on the properties, relationships, orientations, positions and transformations of 2-D shapes.

However, for progression from grade 6 to grade 7, the learner's experience shifts from the intermediate phase grades 4 - 6, to the senior phase grades 7 - 9. Hence, the specific content focus moves from the classification and more detailed description of characteristics and properties of 2-D shapes; giving of opportunities to draw 2-D shapes further, describing locations (positions), transformation and symmetry (DBE, 2011b: 6), to drawing and constructing a wide range of 2-D shapes using appropriate geometric instruments; developing an appreciation for the use of constructions to investigate the properties of 2-D shapes; developing clear and more precise descriptions and classification categories of geometric figures and solving a variety of geometric problems drawing on known properties of geometric figures (DBE, 2011c: 10). The appropriate geometric instruments include the compass, ruler and the protractor (DBE, 2011c: 30).

Appendix F provides the full extent of results of the evaluation of the five grade 6 series of textbooks for progression from grade 6 to grade 7 on the CAPS-based teaching-learning activities and their corresponding five geometric skills on the Mathematics topics, concepts and skills of grade 7. Appendix F and the teaching-learning activities it consists of, are the topics, concepts and skills of grade 7 contained in the grade 7 - 9 senior phase Mathematics

CAPS document (DBE, 2011a: 24 - 27; 365 - 399), which are relevant for progression from grade 6 to grade 7. The amount of these grade 7 topics, concepts and skills in the grade 6 textbooks is an indication of the extent of progression and link between the lower grade 6 and higher grade 7 (DBE, 2011b: 4, 12). The progression contributes towards the development of conceptual understanding of 2-D shapes in both grades 6 and 7 and beyond; hence it is important to establish its existence or lack thereof as a possible enabler or hindrance to the development of conceptual understanding of 2-D shapes.

Table 4.8 below in this section 4.4.4.5, is a shortened version of Appendix F. It is divided into two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 6 series of textbooks coding and scores allocated to each textbook during the evaluation. As represented in the CAPS-based measuring tool in Appendix F, the five geometric skills are underpinned by the teaching-learning activities that should be provided to learners in the textbooks. The five grade 6 textbooks evaluated are designated S 1, S 2, S 3, S 4 or S 5, where S is an abbreviation of the word “series”.

The scores obtained by each grade 6 textbook of the series during the evaluation are listed under the grade 6 textbook’s series designation to correspond with each skill in Table 4.8 and with both the specific skill and teaching-learning activity in Appendix F. In both Appendix F and Table 4.8, the scores and total scores of each grade 6 textbook of the series have been entered side by side in columns for comparison with one another and the possible maximum perfect scores on the specific skill. The total scores of each grade 6 series textbook is provided at the bottom of each column of the grade 6 textbook scores and can also be compared with one another and with the possible maximum total score for the five geometric skills. An account of why each geometric skill in Table 4.8, based on its component teaching-learning activities, has not obtained a perfect score follows the table in the same order that the skills and results are presented in the table and relevant Appendix F. The amount of score by which each skill has come short of the possible maximum perfect score depends on the scores of the individual teaching-learning activities in Appendix F that were either partially or completely not complied with by the textbook contents as expected by the CAPS.

The specific teaching-learning activities in Appendix F which are not fully complied with by the textbooks, as indicated by a partial or a zero score instead of a full score of 1.00, are also named as part of giving the results of every skill for every series of textbook, but also as identifying how the lack of compliance resulted, can be verified and then corrected. The

numbers of aspects for full compliance by textbooks have been included in brackets or written in italics in Appendix F, in the relevant teaching-learning activity.

Table 4.8: Grade 6 textbook series' percentage CAPS compliance (progression to grade 7)

GEOMETRIC SKILLS	Grade 6 series coding and Scores (raw and %) for Progression				
	S 1	S 2	S 3	S 4	S 5
A. Visual Skills Score : 4.00	2.00 (50%)	2.00 (50%)	2.00 (50%)	2.00 (50%)	2.00 (50%)
B. Verbal / Written Skills Score : 24.00	9.12 (38%)	4.75 (20%)	8.36 (35%)	3.61 (15%)	8.37 (35%)
C. Drawing Skills Score : 4.00	2.75 (69%)	2.25 (56%)	3.25 (81%)	2.25 (56%)	2.25 (56%)
D. Logical Skills Score : 9.00	5.63 (63%)	5.60 (62%)	5.80 (64%)	3.43 (38%)	5.33 (59%)
E. Applied Skills Score : 4.00	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
TOTAL SCORES : 45.00	19.5**(43%)**	14.60 **(32%)**	19.41**(43%)**	11.29 **(25%)**	17.95 **(40%)**

4.4.1.5.1 Visual skills score *(Possible: 4.00)*

Hereafter follow the results of the evaluation based on Appendix F and the specific teaching-learning activities A 1.1 - 1.4. The abbreviated version of these results is section A of Table 4.8 above and the full version is in Appendix F. All the teaching-learning activities not allocated a perfect score of 1 lacked the visual skills of the 2-D shapes as given below.

All the five series of textbooks do not engage in the topics, concepts and skills of similarity and congruency, hence the zero scores for A 1.2 and A 1.3 of Appendix F. The total scores of all the series textbooks are all 2.00, which is 2.00 full scores below the possible maximum perfect score of 4.00 for this visual skill, entirely as a result of the textbooks completely lacking the similarity and congruency concepts. The compliance of all the textbooks on this skill is thus 50%.

4.4.1.5.2 Verbal / written skills score (Possible: 24.00)

Hereafter follows the results of the evaluation based on Appendix F and the specific teaching-learning activities B 1.1 - 1.10, B 2.1 - 2.13 and B 3.1. The abbreviated version of these results is section B of Table 4.8 above and the full version is in Appendix F. All the teaching-learning activities not allocated a perfect score of 1 lacked the verbal / written skills of the 2-D shapes as given below.

Series 1 neglects to name any other parts of the circle except the radius in B 1.1, thus scores 6/7 (0.86) less. It also neglects to name any triangles at all either according to their sides or their angles in both B 1.2 and B 1.3 respectively, both resulting in zero scores. Furthermore there are no activities for naming quadrilaterals with at least one pair of adjacent sides equal and perpendicular sides or even one pair of opposite sides parallel in B 1.6, 1.7, 1.9,

resulting in zero scores in all three cases.

Consistent with the naming, the series only describes the radius and no other parts of the circle in B 2.1; describes only the equilateral triangle according to both the equality of sides and angles in B 2.2 and not the other two triangles in B 2.3 and B 2.4. Neither are there activities for describing quadrilaterals with at least one pair of adjacent sides equal or one pair of opposite sides parallel for B 2.7 and B 2.10. There are no instructions to describe similar and congruent figures in B 2.12 and B 2.13. An overall score of 9.12 demonstrates a less than 50% progression compliance of 38% for the series, where the maximum total score for the skill is 24.

Series 2 neglects to identify and / or name the different parts of a circle and triangles according to sides and angle in B 1.1, B 1.2 and B 1.3 respectively. Similarly, it fails to identify and / or name quadrilaterals, with at least one pair of adjacent sides equal; with perpendicular sides; with two pairs of opposite sides parallel and with one pair of opposite sides parallel in B 1.6 – B 1.9.

Consistent with the naming, the series neglects activities to describe parts of a circle, and then equilateral, isosceles and scalene triangles according to sides and angles in B 2.1 - 2.4. Likewise, activities on the description of quadrilateral with all at least one pair of adjacent sides equal; with perpendicular sides; with two pairs of opposite sides parallel; with one pair of opposite sides parallel and with four angles as right angles are missing for B 2.7 - B 2.11. The series has no activities to describe similar and congruent figures in B 2.12 and B 2.13. An overall score of 4.75 demonstrates a less than 25% progression compliance of 20% for the series, where the maximum total score for the skill is 24.

Series 3 only names the circumference, radius and diameter of the circle and neglects the other four parts, thereby losing a 4/7 (0.57) score in B 1.1. It has no activities to name the triangles according to sides and angles in B 1.2 and B 1.3; neither does it have activities to name the quadrilaterals in terms of length of sides; with at least one pair of adjacent sides equal; with perpendicular sides and with one pair of opposite sides parallel in B 1.4, B 1.6 - 1.7 and B 1.9.

Series 3 only has instructions to describe the circumference, radius and diameter of the circle and neglects the other four parts, thus scoring a 4/7 (0.57) less. It has no activities to describe the equilateral triangle(s) according to their sides and angles in B 2.2; quadrilaterals with a least one pair of adjacent sides equal and with perpendicular sides in B 2.7, B 2.8 and

B 2.10. Furthermore, series 3 has no activities to describe similar and congruent figures in B 2.12 and B 2.13. An overall score of 8.36 demonstrates a less than 50% progression compliance of 35% for the series, where the maximum total score for the skill is 24.

Series 4 only names the arc, diameter and radius of a circle as parts of the circle in B 1.1, thus a loss of 4/7 (0.57) score for failing to name the rest. It fails to name any triangles according to sides or angles in B 1.2 and B 1.3; fails to name quadrilaterals in terms of all sides being equal, opposite sides being equal, at least one pair of adjacent sides equal, perpendicular sides equal, two pairs of opposite sides parallel, one pair of opposite sides parallel or even all four angles as right angles in B 1.4 – B 1.10 respectively.

Consistent with the naming of parts of the circle, series 4 only describes the arc, radius and diameter, thus again scoring 4/7 (0.57) less in B 2.1 for failing to describe the rest of the parts. Furthermore, it describes only the square as a quadrilateral with all sides equal in B 2.5, for a 1/2 (0.50) score, and describes only the rectangle and parallelogram as quadrilaterals with opposite sides equal in B 2.6, losing a 2/4 (0.50) score. It entirely fails to describe equilateral, isosceles, and scalene triangles according to sides and angles in B 2.2 – B 2.4. Likewise, it fails to include activities on the description of quadrilateral with at least one pair of adjacent sides equal; with perpendicular sides; with two pairs of opposite sides parallel; with one pair of opposite sides parallel and with four angles as right angles for B 2.7 - B 2.11. The series has no activities to describe similar and congruent figures in B 2.12 and B 2.13. An overall score of 3.61 demonstrates a less than 25% progression compliance of 15% for the series, where the maximum total score for the skill is 24. Series 4 has the lowest progression compliance of all the five series.

Series 5 names the circumference alone as a part of the circle in B 1.1, hence the loss of a 6/7 (0.86) score; lacks to name the right-angle triangle, the rhombus as a quadrilateral with all sides equal; the parallelogram, rhombus and rectangle as quadrilaterals with opposite sides equal and kite as a quadrilateral with at least one of the adjacent sides equal, thereby being partially compliant in B 1.3 – B 1.6, and losing scores of 1/3 (0.33), 1/2 (0.50), 3/4 (0.75) and 1/3 (0.33), respectively. Furthermore, it totally fails to name any quadrilaterals, with perpendicular sides; with two pairs of opposite sides parallel and with one pair of opposite sides parallel in B 1.7 – B 1.9.

Consistent with naming, series 5 describes the circumference alone as a part of the circle in B 2.1, hence losing a 6/7 (0.86) score. It also lacks the rhombus as a quadrilateral with all sides equal and rectangle as a quadrilateral with all four angles being right angles in B 2.5

and B 2.11, resulting in losses of 1/2 (0.50) score in each case. It totally fails to describe quadrilaterals, with opposite sides equal; with at least one pair of adjacent sides equal; with perpendicular sides; with two pairs of opposite sides parallel and with one pair of opposite sides parallel in B 2.6 - B 2.10. Furthermore, the series has no activities to describe similar and congruent figures in B 2.12 and B 2.13. An overall score of 8.37 demonstrates a less than 50% progression compliance of 35% for the series, where the maximum total score for the skill is 24.

4.4.1.5.3 Drawing skill score (Possible: 4.00)

Hereafter follow the results of the evaluation based on Appendix F and the specific teaching-learning activities C 1.1 - 1.4. The abbreviated version of these results is section C of Table 4.8 above and the full version is in Appendix F. All the teaching-learning activities not allocated a perfect score of 1 lacked the drawing skills of the 2-D shapes as given below.

Series 1 entirely lacks drawings of lines of symmetry in transformations in C 1.1. It has no construction(s) of drawing perpendicular lines in C 1.4, thus losing a 1/4 (0.25) score. Its resulting overall score of 2.75 is 1.25 less than the maximum possible total score of 4.00, and represents a 69% compliance with the CAPS.

Series 3 only lacks the construction of angles, parallel and perpendicular line in C 1.4, thereby losing a 3/4 (0.75) score. Its overall drawing skill's score of 3.25 is the highest of all five series and represents an 81% compliance with the CAPS.

Series 2, 4 and 5 all fail to include the drawing of the lines of symmetry in transformations in C 1.1 as well as the construction of angles, parallel and perpendicular lines in C 1.4. The result is the loss of 1.00 and 3/4 (0.75) scores, respectively, with overall scores of 2.25, which are 1.75 below the possible maximum of 4.00 for all three series. All three series have an equal progression compliance of 44% for the skill.

4.4.1.5.4 Logical skills score (Possible: 9.00)

Hereafter follow the results of the evaluation based on Appendix F and the specific teaching-learning activities D 1.1 - 1.9. The abbreviated version of these results is section D of Table 4.8 above and the full version is in Appendix F. All the teaching-learning activities not allocated a perfect score of 1 lacked the logical skills of the 2-D shapes as given below.

Series 1 lacks comparison of shapes by straight angle(s) in D 1.1 and neglects to sort and compare acute and obtuse-angled triangles in D 1.3, resulting in scores of 1/5 (0.20) and

2/3 (0.67) less than the possible maximum for the skill respectively. It neglects to include the rhombus, trapezium and kite in the comparison of quadrilaterals according to lengths of sides, parallel sides and sizes of angles in D 1.4, 1.5 and 1.7, respectively, thus losses of 3/6 (0.50) scores in all three cases. Series 1 completely fails to sort and compare quadrilaterals according to perpendicular sides in D 1.6. It has an overall score of 5.63 which is 3.37 less than the maximum possible score for the skill, representing a 63% compliance with the CAPS.

Series 2 neglects to include the rhombus, trapezium and kite in the comparison of quadrilaterals according to lengths of sides in D 1.4, leading to a 3/6 (0.50) less score. Furthermore, it neglects the comparison of quadrilaterals in terms of parallel and perpendicular sides in D 1.5 and 1.6, leading to the zero scores. Its total score of 5.60 is a 62% compliance with the CAPS.

Series 3 lacks comparison of shapes by straight angle(s) in D 1.1, hence the loss of a 1/5 (0.20) score; only compares the equilateral and isosceles triangles according to sides in D 1.2, neglecting the scalene triangle and thus losing a 1/3 (0.33) score. Furthermore, only the parallel sides of parallelogram and rectangle are covered in D 1.5, resulting in a 4/6 (0.67) loss of score. Its total score of 5.80 is a 64% compliance with the CAPS.

Series 4 has zero scores for neglecting the sorting and comparison of triangles according to both sides and angles in D 1.2 and D 1.3. It only compares a rectangle and parallelogram in D 1.1, according to acute, right and obtuse angles and in D 1.7 according to right angles or not. However, it lacks comparison of quadrilaterals according to perpendicular and parallel sides in D 1.5 – D 1.6. Its total score of 3.43 is a 38% compliance with the CAPS.

Series 5 has a zero score for neglecting the sorting and comparison of triangles according to angles in D 1.3. It neglects the inclusion of the trapezium and kite in the sorting and comparison in D 1.4 and D 1.5, resulting in scores of 2/6 (0.33) less than the possible maximum for the skill in each case. Furthermore, no comparison exists in terms of perpendicular sides and whether angles are right angles or not for D 1.6 and 1.7, leading to the zero score. The total score of 5.33 is 3.67 less than the possible maximum score and represents 59% progression compliance with CAPS.

4.4.1.5.5 Applied skills score (Possible: 4.00)

Hereafter follow the results of the evaluation based on Appendix F and the specific teaching-learning activities E 1.1 - 1.3 and E 2.1. The abbreviated version of these results is section E

of Table 4.8 above and the full version is in Appendix F. All the teaching-learning activities not allocated a perfect score of 1 lacked the applied skills of the 2-D shapes as given below.

The evaluation of all five series 1 up to series 5 textbooks is the same, with none of them ever engaging the learner in solving simple geometric problems described in E 1.1 - 1.3, thus the zero score for each. Similarly, all the textbooks fail to engage the learner in the accurate measuring of angles with a protractor in E 2.1, scoring zero again on the teaching-learning activity. Consequently, the resulting total score for all five series of textbooks is 0.00 for the skill with a maximum possible score of 4.00. There is thus 0% progression compliance for this skill in all the textbooks.

4.5 THE VAN HIELE THEORY-BASED MEASURING INSTRUMENT

4.5.1 Evaluation results

The evaluation results of the grades 4 - 6 Mathematics learner textbooks according to the three Van Hiele-based measuring instruments are presented in two different formats, namely, the long format of Appendices G - I and the short format of Tables 4.9 - 4.11 below. Appendices G - I provide the full extent of results of the evaluation of the five grade 4 - 6 series of textbooks on the Van Hiele-based level descriptor-learner response activities and their corresponding five geometric skills on the relevant topics, concepts and skills. Tables 4.9 - 4.11 are the shortened versions of Appendices G - I and have been incorporated into the sections giving the results of every textbook according to grade and series. In contrast to the appendices, the tables within every section below only provide two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 4 - 6 series of textbooks coding and scores (raw and percentages) allocated to each textbook during the evaluation.

The individual scores of each series corresponding to the geometric skills are given in the tables for comparison with the possible maximum scores of each geometric skill. The total scores of each series on all geometric skills are also given for comparison with the possible maximum scores of all the geometric skills.

4.5.1.1 Grade 4 textbooks: Van Hiele level 0 compliance evaluation and results

The Van Hiele level 0 together with its defining and corresponding knowledge and skills is roughly apportioned for achievement through-out the foundation phase grades R - 3 of schooling and the geometric education of a learner in the South African education system (see 2.2.3.7). However, appropriate and relevant teaching and learning developed in the form of the level 0 descriptors and sample learner responses must take place for the level to

be reached at the end of grade 3. Level 0 is achieved when the learner can identify and operate on shapes and other geometric configurations according to their appearance (Fuys et al., 1988: 58). The Van Hiele level 0 descriptors and sample learner responses are listed according to the five geometric skills in Appendix G as an evaluating tool for establishing the pedagogical approach and teaching and learning (instructional) design of every grade 4 of the series of textbooks.

Appendix G also provides the full extent of results of the evaluation of the five grade 4 series of textbooks on the Van Hiele-based level 0 descriptor-learner responses and their corresponding five geometric skills on the progression of the topics, concepts and skills from grade 3 to grade 4. Table 4.9 below in this section 4.5.1.1 is a shortened version of Appendix G. It is divided into two main columns consisting of the five different geometric skills listed as A to E in rows, and the grade 4 series of textbooks coding and scores (raw and %) allocated to each textbook during the evaluation. As represented in the Van Hiele measuring tool in Appendix G, the five geometric skills are underpinned by the level descriptor-learner responses activities that should be provided to learners in the textbooks. The five grade 4 textbooks are designated S 1, S 2, S 3, S 4 or S 5, where S is an abbreviation of the word “series”.

The scores obtained by each grade 4 textbook of the series during the evaluation are listed under the grade 4 textbooks series designation to correspond with each skill in Table 4.9 and with both the specific skill and level descriptor-learner responses in Appendix G. In both Appendix G and Table 4.9, the scores and total scores of each grade 4 textbook of the series have been entered side by side in columns for comparison with one another and the possible maximum perfect scores on the specific skill. The total scores of each grade 4 series textbook is provided at the bottom of each column of the grade 4 textbook scores and can also be compared with one another and with the possible maximum total score for the five geometric skills.

An account of why each geometric skill in Table 4.9, based on its component combination of level descriptor and sample learner responses, has not obtained a perfect score follows the table in the same order that the skills and results are presented in the table and Appendix G. The amount of score by which each skill has come short of the possible maximum perfect score depends on the score(s) of the level descriptor-learner responses in Appendix G that were either partially or completely not complied with by the textbook contents as expected by the Van Hiele Theory of Geometric Thought.

The specific level descriptor-learner responses in Appendix G which are not fully complied with by the textbooks, as indicated by a partial or a zero score instead of a full score of 1.00 are also named as part of giving the results of every skill for every series of textbook, but also as identifying how the lack of compliance resulted; can be verified and then corrected. The numbers of aspects needed for full compliance by textbooks, have been included in brackets or written in italics in Appendix G, in the relevant level descriptor-learner responses.

Table 4.9: Grade 4 textbook series' percentage Van Hiele Level 0 Compliance

GEOMETRIC SKILLS	**Grade 4 series coding and scores (raw and %)**				
	S 1	**S 2**	**S 3**	**S 4**	**S 5**
A. Visual Skills Score **:** 9.00	6.33 (70%)	4.17 (46%)	4.83 (54%)	5.17(57%)	6.33 (70%)
B. Verbal / Written Skills Score **:** 6.00	1.00 (17%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
C. Drawing Skills Score **:** 5.00	2.73 (55%)	3.07 (61%)	3.73 (75%)	3.73 (75%)	3.73 (75%)
D. Logical Skills Score **:** 3.00	1.00 (33%)	1.00 (33%)	1.00 (33%)	1.00 (33%)	1.00 (33%)
E. Applied Skills Score **:** 6.00	3.00 (50%)	4.00 (67%)	3.50 (58%)	4.00 (67%)	3.50 (58%)
TOTAL SCORES : 29.00	14.06**(48%)**	12.24**(42%)**	13.06**(45%)**	13.90**(48%)**	14.56**(50%)**

4.5.1.1.1 Visual skills score *(Possible: 9.00)*

The following are the results of the evaluation based on Appendix G and the specific Van Hiele level 0 descriptors-learner response activities A 1.1 - 1.3 and A 2.1 - 2.2. The abbreviated version of these results is section A of Table 4.9 above and the full version is in Appendix G. All the level 0 descriptors-learner activities not allocated a perfect score of 1 lacked the visual skills of the 2-D shapes as given below.

Series 1 does not include the topic of angles in both A 1.2v and A 1.3, hence zero scores. No parallel or perpendicular lines are identified in A 1.2v, thus the loss of a 4/6 (0.67) score, and there is no fitting of jigsaw pieces together to reveal a bigger picture in A 2.2, resulting in a zero score. The total series score of 6.33 represents a 70% compliance with the Van Hiele level 0 on the visual skills.

Series 2 also does not include the topic of angles in both A 1.2i and A 1.3, hence zero scores for both. An equilateral triangle is only found in one position in A 1.2ii thus the loss of 1/6 (0.17) and there are no parallel or perpendicular lines identified in A 1.2v, thus the loss of 4/6 (0.67). Furthermore, there is no recognition of shapes embedded in others or the fitting of jigsaw pieces in A 2.1 and A 2.2, thus zero scores for both. The series score of 4.17 represents a 46% compliance with the Van Hiele level 0 on the visual skills.

Series 3 also does not include the topic of angles in both A 1.2i and A 1.3, hence zero scores for both. No scalene triangle is identifiable at all in any position and only one equilateral

triangle in one position is identifiable, hence the loss of 3/6 (0.50) in A1.2ii. Still in A 1.2v, no parallel or perpendicular lines are identifiable, resulting in a loss of a 4/6 (0.67) score. There is no fitting of jigsaw pieces in A 2.2, hence the zero score. The series score of 4.83 represents a 54% compliance with the Van Hiele level 0 on the visual skills.

Series 4, like the other three before, does not include the topic of angles in both A 1.2i and A 1.3, hence the zero scores. It has many equilateral triangles of different sizes in one position only in A1.2ii, thus losing a 1/6 (0.17) score; has no parallel or perpendicular lines identifiable in A1.2v and has no fitting of jigsaw pieces in A 2.2.The series score of 5.17 represents a 57% compliance with the Van Hiele level 0 on the visual skills.

Series 5 also does not include the topic of angles in both A 1.2i and 1.3, hence zero score in both cases. Still in A 1.2v, it has no parallel or perpendicular lines identifiable in any position, hence, the loss of a 4/6 (0.67) score for a total score of 6.33 which represents a 70% compliance with the Van Hiele level 0 on the visual skills.

4.5.1.1.2 Verbal / Written skills score (*Possible: 6.00*)

The following are the results of the evaluation based on Appendix G and the specific Van Hiele level 0 descriptors-learner response activities B 1.1 - 1.3 and B 2.1 - 2.3. The abbreviated version of these results is section B of Table 4.9 above and the full version is in Appendix G. All the level 0 descriptors-learner activities not allocated a perfect score of 1 lacked the verbal / written skills of the 2-D shapes as given below.

Series 1 has the appropriate level descriptor and the sample learner response for B 1.1 only by shading and calling angles of triangles, square, pentagon, hexagon corners, hence a full score. However, B 1.2 - 1.3 and B 2.1 - 2.3 are all zero scores for a total score of 1.00, representing a 16.67% compliance with the Van Hiele level 0 on the verbal / written skills.

Series 3 and 5 only describe the square and rectangle by their 4 right angles in terms of properties and not by their appearance as a whole. The rectangle and an angle are not described in line with A 2.3, hence the zero score on all of them. The two series have a 0.00% compliance with the Van Hiele level 0 on the verbal / written skills.

Series 2 and 4 have none of the appropriate level descriptors and sample responses, thus the zero scores in all the aspects as reflected in appendix F section B. Both series have a 0.00% compliance with the Van Hiele level 0 on the verbal / written skills.

4.5.1.1.3 Drawing skills score (*Possible: 5.00*)

The following are the results of the evaluation based on Appendix G and the specific Van Hiele level 0 descriptors-learner response activities C 1.1 - 1.5. The abbreviated version of these results is section C of Table 4.9 above and the full version is in Appendix G. All the level 0 descriptors-learner activities not allocated a perfect score of 1lacked the drawing skills of the 2-D shapes as given below.

Series 1 has no parallel or perpendicular lines drawn, hence the loss of a 2/3 (0.67) score in C 1.2. It has no outlines or drawings of angles, lines or ladders on the grid which are independent from 2-D shapes, resulting in the loss of a score of 3/5 (0.60) in C 1.3. Furthermore, it has no copying of patterns, hence the zero score in C 1.5. The total score of 2.73 for the series represents a 55% compliance with the Van Hiele level 0 on the drawing skills.

Series 2 has no patterns of squares and rectangles made with match sticks; has no parallel or perpendicular lines drawn and has no outlines or drawings of angles, lines or ladders on the grid which are independent from 2-D shapes in C 1.1 - 1.3, respectively. The resulting scores are 2/3 (0.67), 2/3 (0.67) and 3/5 (0.60) less than the possible maximum score respectively, for a total skills score of 3.07. The total score for the series represents 61% compliance with the van Hiele level o on the drawings skills.

Series 3, 4 and 5 have no parallel or perpendicular lines drawn and have no outlines or drawings of angles, lines or ladders on the grid which are independent from 2-D shapes in C 1.2 and C 1.3, respectively. The resulting scores are 2/3 (0.67) and 3/5 (0.60) less than the possible maximum score respectively, for a total skills score of 3.7 for all three. The score of 3.73 of all three series of textbooks represents a 75% compliance with the Van Hiele level 0 on the drawings skills in them.

4.5.1.1.4 Logical skills score (*Possible: 3.00*)

The following are the results of the evaluation based on Appendix G and the specific Van Hiele level 0 descriptors-learner response activities D 1.1 - 1.3. The abbreviated version of these results is section D of Table 4.9 above and the full version is in Appendix G. All the level 0 descriptors-learner activities not allocated a perfect score of 1 lacked the logical skills of the 2-D shapes as given below.

Series 1 - 5 have no level descriptors leading to the differentiation between a square and rectangle in terms of width and / or length in D 1.2 and do not sort the cut-out shapes of

quadrilaterals according to which “they look alike” in D 1.3. The result for all five series is zero scores for D 1.2 and D 1.3 for total scores of 1.00. The score of 1.00 for all three series of textbooks represents a 33% compliance with the Van Hiele level 0 on the logical skills in them.

4.5.1.1.5 Applied skills score (*Possible: 6.00*)

The following are the results of the evaluation based on Appendix G and the specific Van Hiele level 0 descriptors-learner response activities E 1.1 - 1.3 and E 2.1 - 2.3. The abbreviated version of these results is section E of Table 4.9 above and the full version is in Appendix G. All the level 0 descriptors-learner activities not allocated a perfect score of 1 lacked the applied skills of the 2-D shapes as given below.

All five series 1 - 5 neglect to verify that opposite sides of a rectangle are parallel in E 1.2 and also neglect to use the transparent “angle overlay” to find the measure of the third angle of a triangle in E 1.3, hence scoring zeros in both combinations of level descriptor and sample learner responses.

Series 1 has a zero score for introducing both the “equal sides of the square” and “right angles or square corners” in E 2.1, contrary to the level descriptor-learner response activity.

Series 3 and 5 both lost 1/2 (0.50) scores in E 1.2 for introducing the “equal sides of the square”, contrary to the level descriptor-learner response activity. In agreement with the level descriptor-learner response activity, they do not introduce the “right angles or square corners”, thus the gain of 1/2 (0.50) scores each.

In agreement with E 2.2 and E 2.3 level descriptor-learner response activities, series 1 - 5 do not generalise equal sides for all squares in E 2.2 and neither do they use the “all, some, every, none” and other such quantifiers in E 2.3, thus scoring the maximum score of 1.

Series 1 with a total score of 3.00 has a 50% compliance with the Van Hiele level 0 on the applied skills. Series 3 and 5, each with a total score of 3.50 have the second highest compliance of 58%, while series 2 and 4 with a total score of 4.00 have the highest compliance of 67% of the Van Hiele level 0 on the applied skills.

4.5.1.2 Grade 5 textbooks: Van Hiele level 1 compliance evaluation and results

The Van Hiele level 1 together with its defining and corresponding knowledge and skills is roughly apportioned for achievement through-out the intermediate phase grades 4 - 6 of

schooling and the geometric education of a learner in the South African education system (see 2.2.3.7). However, appropriate and relevant teaching and learning developed in the form of the level 1 descriptors and sample learner responses must take place for the level to be achieved at the end of grade 6. Level 1 is achieved when the learner can analyse figures in terms of their components and relationships between components, establish properties of a class of figures empirically, and use the properties to solve problems (Fuys et al., 1988: 60). The Van Hiele level 1 descriptors and sample learner responses are listed according to the five geometric skills in Appendix H as an evaluating tool for establishing the pedagogic approach and teaching and learning (instructional) design of every grade 5 series of textbooks.

Appendix H also provides the full extent of results of the evaluation of the five grade 5 series of textbooks on the Van Hiele-based level 1 descriptor-learner responses and their corresponding five geometric skills of the topics, concepts and skills of grade 5. Table 4.10 below in this section 4.5.1.2, is a shortened version of Appendix H. It is divided into two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 5 series of textbooks' coding and scores allocated to each textbook during the evaluation. As represented in the Van Hiele-based measuring tool in Appendix H, the five geometric skills are underpinned by the level 1 descriptor-learner responses that should be provided to learners in the textbooks. The five grade 5 textbooks are designated S 1, S 2, S 3, S 4 or S 5, where S is an abbreviation of the word "series".

The scores obtained by each grade 5 textbook of the series during the evaluation are listed under the grade 5 textbooks series designation to correspond with each skill in Table 4.10 and with both the specific skill and level 1 descriptor-learner responses in Appendix H. In both Appendix H and Table 4.10, the scores and total scores of each grade 5 textbook of the series have been entered side by side in columns for comparison with one another and the possible maximum perfect scores on the specific skill. The total scores of each grade 5 series textbook is provided at the bottom of each column of the grade 5 textbook scores and can also be compared with one another and with the possible maximum total score for the five geometric skills. An account of why each geometric skill in Table 4.10, based on its component level descriptor-learner responses, has not obtained a perfect score, follows the table in the same order that the skills and results are presented in the table and Appendix H. The amount of score by which each skill has come short of the possible maximum perfect score depends on the score(s) of the level 1 descriptor-learner responses in Appendix H that were either partially or completely not complied with by the textbook contents as expected by the Van Hiele Theory of Geometric Thought.

The specific level 1 descriptor-learner responses in Appendix H which are not fully complied with by the textbooks, as indicated by a partial or a zero score instead of a full score of 1.00, are also named as part of giving the results of every skill for every series of textbook, but also as identifying how the lack of compliance resulted; can be verified and then corrected. The numbers of aspects needed for full compliance by textbooks, have been included in brackets or written in italics in Appendix H, in the relevant combination of level 1 descriptor and sample learner responses.

Table 4.10: Grade 5 textbook series' percentage Van Hiele Level 1 compliance

GEOMETRIC SKILLS	**Grade 5 series coding and scores (raw and %)**				
	S 1	**S 2**	**S 3**	**S 4**	**S 5**
A. Visual Skills Score **:** 6.00	2.00 (33%)	0.00 (0%)	1.67 (28%)	2.00 (33%)	1.33 (22%)
B. Verbal / Written Skills Score **:** 8.00	2.67 (33%)	1.00 (13%)	2.17 (27%)	3.33 (42%)	2.67 (33%)
C. Drawing Skills Score **:** 1.00	1.00 (100%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	1.00 (100%)
D. Logical Skills Score **:** 5.00	1.25 (25%)	1.25 (25%)	0.25 (5%)	1.50 (30%)	1.50 (30%)
E. Applied Skills Score **:** 8.00	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
TOTAL SCORES : 28.00	6.92**(25%)**	2.25**(8%)**	4.09**(15%)**	6.83**(24%)**	6.50**(23%)**

4.5.1.2.1 Visual skills score (Possible: 6.00)

The following are the results of the evaluation based on Appendix H and the specific Van Hiele level 1 descriptor-learner response activities A 1.1 - 1.6. The abbreviated version of these results is section A of Table 4.10 above and the full version is in Appendix H. All the level 1 descriptor-learner activities not allocated a perfect score of 1 lacked the visual skills of the 2-D shapes as given below.

Series 1 does not include the parallelogram in A 1.1, hence the loss of a 1/3 (0.33) score. Furthermore, it neglects to include the equilateral triangle and rectangle in A 1.3, thus the loss of a 2/3 (0.67) score. Congruence of the opposite angles, diagonals of quadrilaterals and of angles in a tiling pattern in A 1.2, 1.5 and 1.6 have all been totally neglected, thus earning the series zero score for each. The total score of 2.00 for the series represents a 33% compliance with the Van Hiele level 1 descriptor-learner activities of the visual skills.

Series 2 neglects all the appropriate sample learner responses for the level 1 descriptor, thus earning a zero scores for A 1.1 - 1.6. The series has a 0% compliance with the Van Hiele level 1 on the visual skills.

Series 3 does not include the rhombus in A 1.1, thus losing a 1/3 (0.33) score; neglects an equilateral triangle in A 1.3, resulting again in a loss of a 1/3 (0.33) score and neglects to include both the equilateral and rhombus in A 1.4, resulting in the 2/3 (0.67) loss of score.

The congruence of the opposite angles, diagonals of quadrilaterals and of angles in a tiling pattern in A 1.2, 1.5 and 1.6 have all been totally neglected, thus earning the series zero score for each. The total score of 1.67 is a 28% compliance with Van Hiele level on the visual skills.

Series 4 does not include a rhombus and parallelogram in A 1.1, leading to a 2/3 (0.67) loss in score. The rhombus is also not included in A 1.4, thus the 1/3 (0.33) loss in score. Series 4 also neglects to include the congruence of the opposite angles, diagonals of quadrilaterals and of angles in a tiling pattern in A 1.2, 1.5 and 1.6, respectively, hence earning the series zero score for each. The total score of 2.00 is a 33% compliance with Van Hiele level on the visual skills.

Series 5 does not include the rhombus and parallelogram in A 1.1, thus losing a 2/3 (0.67) score; neglects an equilateral triangle in A 1.3, resulting again in a loss of a 1/3 (0.33) score and neglects to include both the equilateral and rhombus in A 1.4, resulting in the 2/3 (0.67) loss of score. Similar to series 1 - 4 before it, series 5 also neglects to include the congruence of the opposite angles, diagonals of quadrilaterals and of angles in a tiling pattern in A 1.2, 1.5 and 1.6 respectively, hence earning the series zero score for each. The total score of 1.33 is the lowest of the five series of textbooks and represents a 22% compliance with Van Hiele level on the visual skills.

4.5.1.2.2 Verbal / Written skills score (Possible: 8.00)

The following are the results of the evaluation based on Appendix H and the specific Van Hiele level 1 descriptor-learner response activities B 1.1 - 1.4, B 2.1, B 3.1 - 3.2 and B 4.1. The abbreviated version of these results is section B of Table 4.10 above and the full version is in Appendix H. All the level 0 descriptors-learner activities not allocated a perfect score of 1 lacked the verbal / written skills of the 2-D shapes as given below.

Series 1 and 5 do not include the description of the parallelogram, rhombus, trapezium and kite in B 3.2 and also do not list the properties of the same quadrilaterals in B 4.1, hence the losses of 4/6 (0.67) in both cases. Furthermore, the two series neglects the appropriate vocabulary and relationships of opposite sides being parallel; diagonals that bisect each other; corresponding and alternating angles being congruent and co-interior angles being supplementary in B 1.1 - 1.4 respectively, thus earning zero scores for the missing sample learner responses. Both series have a total score of 2.67 representing a 33% compliance with Van Hiele level 1 on the verbal / written skills.

Series 2 neglects the appropriate vocabulary and relationships, of opposite sides being parallel; diagonals that bisect each other; corresponding and alternating angles being congruent and co-interior angles being supplementary in B 1.1 - 1.4 respectively, thus earning zero scores for the missing sample learner responses. Furthermore, the series neglects the identification of a shape given some of its properties as clues; fails to describe the six quadrilaterals or even to list many properties of quadrilateral in B 2.1, 3.2 and B 4.1. Its total score of 1.00 is a 13% compliance of the Van Hiele level 1 of the visual / written skills.

Series 3 neglects the parallelogram as having opposite sides that are in B 1.1, hence the loss of a 1/2 (0.50) score. It fails to include the description of the parallelogram, rhombus, trapezium and kite in B 3.2 and also does not list the properties of the same quadrilaterals in B 4.1, hence the losses of 4/6 (0.67) in both cases. Furthermore, it neglects the appropriate vocabulary and relationships of diagonals that bisect each other; corresponding and alternating angles being congruent and co-interior angles being supplementary in B 1.2 - 1.4, respectively, thus earning zero scores for the missing sample learner responses. It also neglects the identification of a shape given some of its properties as clues in B 2.1, thus scoring a zero in the case as well. Its total score of 2.17 is a 27% compliance of the Van Hiele level 1 of the visual / written skills.

Series 4 only neglects to include the kite and trapezium in the description of the six quadrilaterals and the listing of many properties of quadrilateral in B 3.2 and B 4.1, hence, losing scores of 2/6 (0.33) in each case. Like the other series, it neglects the appropriate vocabulary and relationships of opposite sides being parallel; diagonals that bisect each other; corresponding and alternating angles being congruent and co-interior angles being supplementary in B 1.1 - 1.4 respectively, thus earning zero scores for the missing sample learner responses. Its highest total score of 3.33 is a 42% compliance of the Van Hiele level 1 of the visual / written skills.

4.5.1.2.3 Drawing skills score *(*Possible: 1.00*)*

The following are the results of the evaluation based on Appendix H and the specific Van Hiele level 1 descriptor-learner response activities C 1.1. The abbreviated version of these results is section C of Table 4.10 above and the full version is in Appendix H. All the level 1 descriptor-learner activities not allocated a perfect score of 1 lacked the drawing skills of the 2-D shapes as given below.

Series 2, 3 and 4 neglect the interpretation and use of descriptions of a figure based on its properties, to draw it when reading its properties from a property card in C 1.1. The three series lose the 1.00 score and have a 0% compliance with Van Hiele level 1 on the drawing skills.

Series 1 and 2 both comply with C 1.1, thus earning the full score of 1.00, which is a 100% compliance with Van Hiele level 1 on the drawing skills.

4.5.1.2.4 Logical skills score (Possible: 5.00)

The following are the results of the evaluation based on Appendix H and the specific Van Hiele level 1 descriptor-learner response activities D 1.1 - 1.3, D 2.1 and D 3.1. The abbreviated version of these results is section D of Table 4.10 above and the full version is in Appendix H. All the level 1 descriptor-learner activities not allocated a perfect score of 1 lacked the logical skills of the 2-D shapes as given below.

Series 1 and 2 neglect to sort quadrilateral according to pairs of parallel sides; pairs of opposite angles that are equal and pairs of adjacent sides that are equal in D 2.1, hence losing scores of 3/4 (0.75) each. They fail to compare a square and a rhombus as well as a rectangle and a parallelogram according to angles and sides in D 1.2 and D 1.3 respectively, hence the zero score for each. Furthermore, they do not sort quadrilaterals into kites and non-kites to discover and verbalise characteristics of kites in D 3.1, resulting in zero scores for each. The total score of 1.25 for each series is only a 25% compliance with the Van Hiele level 1 descriptor-learner response activities of the logical skills.

Series 3 fails to compare a square and a rectangle; a square and a rhombus as well as a rectangle and a parallelogram according to angles and sides in D 1.1, D 1.2 and D 1.3 respectively, hence the zero scores for each. It neglects to sort quadrilateral according to pairs of parallel sides, pairs of opposite angles that are equal and pairs of adjacent sides that are equal in D 2.1, hence losing the score of 3/4 (0.75). Furthermore, it does not sort quadrilaterals into kites and non-kites to discover and verbalise characteristics of kites in D 3.1, resulting again in a zero score. Its total score of 0.25 is a 5% compliance with the Van Hiele level 1 descriptor-learner response activities of the logical skills.

Series 4 and 5 fail to compare a square and a rhombus as well as a rectangle and a parallelogram according to angles and sides in D 1.2 and D 1.3 respectively, hence the zero scores for each. They neglect to sort quadrilateral according to pairs of parallel sides and pairs of adjacent sides that are equal in D 2.1, hence losing a score of 2/4 (0.50) each.

Furthermore, they do not sort quadrilaterals into kites and non-kites to discover and verbalise characteristics of kites in D 3.1, resulting again in zero scores for each. The total score of 1.50 for each series is 30% compliance with the Van Hiele level 1 descriptor-learner response activities of the logical skill.

4.5.1.2.5 Applied skills score (Possible: 8.00)

The following are the results of the evaluation based on Appendix H and the specific Van Hiele level 1 descriptor-learner response activities E 1.1 - 1.2, E 2.1 - 2.2, E 3.1 - 3.3 and E 4.1. The abbreviated version of these results is section E of Table 4.10 above and the full version is in Appendix H. All the level 1 descriptor-learner activities not allocated a perfect score of 1 lacked the applied skills of the 2-D shapes as given below.

All five series 1 - 5 of textbooks neglect all four level descriptors and accompanying sample learner responses E 1.1 - 1.2, E 2.1 - 2.2, E 3.1 - 3.3 and E 4.1, thus scoring zero on all of them as indicated in Appendix H. The resulting 0% compliance of the applied skills with the Van Hiele level 1 descriptor-learner activities is the lowest of all five skills investigated for the five series of textbooks.

4.5.1.3 Grade 6 textbooks: Van Hiele level 1 compliance evaluation and results

The Van Hiele level 1 together with its defining and corresponding knowledge and skills is roughly apportioned for achievement through-out the intermediate phase grades 4 - 6 of schooling and the geometric education of a learner in the South African education system (see 2.2.3.7). However, appropriate and relevant teaching and learning developed in the form of the level 1 descriptors, and sample learner responses must take place for the level to be achieved. Level 1 is achieved when the learner can analyse figures in terms of their components and relationships between components, establishes properties of a class of figures empirically, and use the properties to solve problems (Fuys et al., 1988: 60). The Van Hiele level 1 descriptors and sample learner responses are listed according to the five geometric skills in Appendix I as an evaluating tool for establishing the pedagogic approach and teaching and learning (instructional) design of every grade 6 series of textbooks.

Appendix I also provides the full extent of results of the evaluation of the five grade 6 series of textbooks on the Van Hiele-based level 1 descriptor-learner responses and their corresponding five geometric skills of the topics, concepts and skills of grade 6. Table 4.11 below in this section 4.5.1.3, is a shortened version of Appendix I. It is divided into two main columns consisting of the five different geometric skills listed as A to E in rows and the grade 6 series of textbooks coding and scores (raw and %) allocated to each textbook during the

evaluation. As represented in the Van Hiele-based measuring tool in Appendix I, the five geometric skills are underpinned by the level descriptor-learner responses that should be provided to learners in the textbooks. The five grade 6 textbooks are designated S 1, S 2, S 3, S 4 or S 5, where S is an abbreviation of the word “series”.

The scores obtained by each grade 6 textbook of the series during the evaluation are listed under the grade 6 textbooks series designation to correspond with each skill in Table 4.11 and with both the specific skill and level descriptor-learner responses in Appendix I. In both Appendix I and Table 4.11, the scores and total scores of each grade 6 textbook of the series have been entered side by side in columns for comparison with each other and the possible maximum perfect scores on the specific skill. The total score of each grade 6 series textbook is provided at the bottom of each column of the grade 6 textbook scores and can also be compared with one another and with the possible maximum total score for the five geometric skills.

An account of why each geometric skill in Table 4.11, based on its component level 1 descriptor-learner responses, has not obtained a perfect score follows the table in the same order that the skills and results are presented in the table and Appendix I. The amount of score by which each skill has come short of the possible maximum perfect score depends on the score(s) of the level descriptor-learner responses in Appendix I that were either partially or completely not complied with by the textbook contents as expected by the Van Hiele Theory of Geometric Thought.

The specific level 1 descriptor-learner responses in Appendix I which are not fully complied with by the textbooks, as indicated by a partial or a zero score instead of a full score of 1 are also named as part of giving the results of every skill for every series of textbook, but also as identifying how the lack of compliance resulted; can be verified and then corrected. The numbers of aspects needed for full compliance by textbooks, have been included in brackets or written in italics in Appendix I, in the relevant level descriptor-learner responses.

Table 4.11: Grade 6 textbook series’ percentage Van Hiele Level 1 compliance

GEOMETRIC SKILLS	**Grade 6 series coding and scores (raw and %)**				
	S 1	**S 2**	**S 3**	**S 4**	**S 5**
A. Visual Skills Score **:** 6.00	3.15 (53%)	2.65 (44%)	1.90 (32%)	2.02(34%)	2.33 (39%)
B. Verbal / Written Skills Score **:** 8.00	4.42 (55%)	2.17 (27%)	2.50 (31%)	3.00 (38%)	3.33 (42%)
C. Drawing Skills Score **:** 1.00	1.00 (100%)	0.00 (0%)	0.00 (0%)	1.00 (100%)	0.00 (0%)
D. Logical Skills Score **:** 5.00	2.50 (50%)	1.50 (30%)	1.00 (20%)	2.75 (55%)	3.00 (60%)
E. Applied Skills Score **:** 8.00	0.67 (8%)	0.00 (0%)	0.33 (4%)	0.00 (0%)	0.67 (8%)
TOTAL SCORES :28.00	11.74 **(42%)**	6.32 **(23%)**	5.73 **(20%)**	8.77 **(31%)**	9.33 **(33%)**

4.5.1.3.1 Visual skills score *(*Possible: 6.00*)*

The following are the results of the evaluation based on Appendix I and the specific Van Hiele level 1 descriptor-learner response activities A 1.1 - 1.6. The abbreviated version of these results is section A of Table 4.11 above and the full version is in Appendix I. All the level 1 descriptor-learner activities not allocated a perfect score of 1 lacked the visual skills of the 2-D shapes as given below.

Series 1 neglects to include the rhombus in A 1.1, hence the loss of a 1/4 (0.25) score. The kite, rhombus and parallelogram are excluded in A 1.2, hence the loss of a 3/5 (0.60) score. Furthermore, the congruence of the diagonals of quadrilaterals and of angles in a tiling pattern in A 1.5 and A 1.6 have all been totally neglected, thus earning the series a zero score for each. The total score of 3.15 for the series is a 53% compliance with the Van Hiele level 1 descriptors-learner response of the visual skills.

Series 2 neglects all but a rhombus in A 1.1, thus losing the 3/4 (0.75) score and neglects the kite, rhombus and parallelogram in A 1.2, thus losing a 3/5 (0.60) score. The congruence of the diagonals of quadrilaterals and of angles in a tiling pattern in A 1.5 and A 1.6 have all been totally neglected, thus the zero score for each. The total score of 2.65 for the series is a 44% compliance with the Van Hiele level 1 descriptors-learner response of the visual skills.

Series 3 covers only the rectangle and parallelogram in A 1.1 and A 1.2, hence the 2/4 (0.50) and 3/5 (0.60) losses in scores, respectively. It neglects the equilateral triangle in A 1.3 and the equilateral triangle and rhombus are neglected in A 1.4, resulting in 1/3 (0.33) and 2/3 (0.67) less scores, respectively. The congruence of the diagonals of quadrilaterals and of angles in a tiling pattern in A 1.5 and A 1.6 have all been totally neglected, thus the zero score for each. The low total score of 1.90 for the series is a 32% compliance with the Van Hiele level 1 descriptors-learner response of the visual skills.

Series 4 neglects the rhombus in A 1.1 and A 1.4, thus scoring 1/4 (0.33) and 1/3 (0.33) less, respectively. The kite and rhombus are neglected in A 1.2, for the loss of a 2/5 (0.40) score. The congruence of the diagonals of quadrilaterals and of angles in a tiling pattern in A 1.5 and A 1.6 have all been totally neglected, thus the zero score for each. The total score of 2.02 for the series is a 34% compliance with the Van Hiele level 1 descriptors-learner response of the visual skills.

Series 5 fails to include the equilateral triangle in both A 1.3 and A 1.4, thus the score of 1/3 (0.33) less in each case. Furthermore, congruence of the opposite angles; diagonals of

quadrilaterals and of angles in a tiling pattern in A 1.2, A 1.5 and A 1.6 have all been totally neglected, thus the zero score for each. The total score of 2.33 for the series is a 38% compliance with the Van Hiele level 1 descriptors-learner response of the visual skills.

4.5.1.3.2 Verbal / Written skills score (Possible: 8.00)

The following are the results of the evaluation based on Appendix I and the specific Van Hiele level 1 descriptor-learner response activities B 1.1 - 1.4, B 2.1, B 3.1 - 3.2 and B 4.1. The abbreviated version of these results is section B of Table 4.11 above and the full version is in Appendix I. All the level 1 descriptor-learner activities not allocated a perfect score of 1 lacked the verbal/written skills of the 2-D shapes as given below.

All five series 1 - 5 do not include the appropriate vocabulary for components and relationships of diagonals, corresponding and alternating angles as well as co-interior angles in B 1.2 - 1.4, resulting in zero scores for all of them.

Series 1 does not include the rhombus in B 1.1, resulting in the 1/4 (0.25) loss of score. The properties of rhombus are also not included either for description or as a list in B 3.2 and B 4.1, leading to score losses of 1/5 (0.20) for each. The total score of 4.42 for the series is a 55% compliance with the Van Hiele level 1 descriptors-learner response of the visual skill in this grade 6 textbook series.

Series 2 does not include the properties of the rhombus, trapezium and kite in B 3.2 and B 4.1, resulting in a score loss of 3/6 (0.50) for each level descriptor and learner response. Furthermore, it has zero scores for not observing the opposite and parallel sides of any quadrilateral in B 1.1 and neglecting using clues to identify a shape in B 2.1. The total score of 2.17 for the series is a 27% compliance with the Van Hiele level 1 descriptors-learner response of the visual skill in this grade 6 textbook series.

Series 3 only recognises the opposite and parallel sides of the rectangle and parallelogram in B 1.1, hence the loss of 2/4 (0.50) score. It does not include the properties of the rhombus, trapezium and kite in B 3.2 and B 4.1, resulting in a score loss of 3/6 (0.50) for each level descriptor and learner response. Lastly, it has a zero score for neglecting to use clues to identify a shape in B 2.1. The total score of 2.50 for the series is a 31% compliance with the Van Hiele level 1 descriptors-learner response of the visual skill in this grade 6 textbook series.

Series 4 has a zero score for not observing the opposite and parallel sides of any quadrilateral in B 1.1. Furthermore, it does not include the properties of the rhombus, trapezium and kite in B 3.2 and B 4.2, resulting in a score loss of 3/6 (0.50) for each level descriptor and learner response. The total score of 3.00 for the series is a 38% compliance with the Van Hiele level 1 descriptors-learner response of the visual skill in this grade 6 textbook series.

Series 5 has a zero score for neglecting B 2.1. It does not include the properties of the kite and trapezium in B 3.2 and B 4.1, hence the loss of a 2/6 (0.33) score for each. The total score of 3.33 for the series is a 42% compliance with the Van Hiele level 1 descriptors-learner response of the visual skill in this grade 6 textbook series.

4.5.1.3.3 Drawing skills score (Possible: 1.00)

The following are the results of the evaluation based on Appendix I and the specific Van Hiele level 1 descriptor-learner response activity C 1.1. The abbreviated version of these results is section C of Table 4.11 above and the full version is in Appendix I. Since there is one level 1 descriptor-learner activity, any series not allocated a perfect score of 1 lacked the drawing skills of the 2-D shapes as given below.

Series 2, 3 and 5 neglect the interpretation and use of descriptions of a figure based on its properties to draw it when reading its properties from a property card in C 1.1. The three series lose the 1.00 score each. The total score of 0.00 for all the three series of textbooks is a 0% compliance with the Van Hiele level 1 descriptor-learner response of the drawing skill in these grade 6 textbooks.

4.5.1.3.4 Logical skills score (Possible: 5.00)

The following are the results of the evaluation based on Appendix I and the specific Van Hiele level 1 descriptor-learner response activities D 1.1 - 1.3, D 2.1 and D 3.1. The abbreviated version of these results is section D of Table 4.9 above and the full version is in Appendix I. All the level 1 descriptor-learner activities not allocated a perfect score of 1 lacked the logical skills of the 2-D shapes as given below.

Series 1 neglects to sort quadrilaterals according to pairs of opposite angles that are equal and pairs of adjacent sides that are equal in D 2.1, hence the loss of a 2/4 (0.50) score. Furthermore, it has zero scores for D 1.2 and D 3.1, for not comparing a square and a rhombus and not sorting quadrilaterals into kites and non-kites respectively. The total score

of 2.50 for the series is a 50% compliance with the Van Hiele level 1 descriptor-learner responses of the logical skills in this grade 6 textbook series.

Series 2 has zero scores for not comparing a square and a rectangle, and a square and a rhombus in D 1.1 and D 1.2 respectively. Another zero score is for not sorting quadrilaterals into kites and non-kites in D 3.1. It neglects to sort quadrilateral according to pairs of parallel sides and pairs of adjacent sides that are equal in D 2.1, hence the loss of a 2/4 (0.50) score. The total score of 1.50 for the series is a 30% compliance with the Van Hiele level 1 descriptor-learner responses of the logical skills in this grade 6 textbook series.

Series 3 neglects to sort quadrilaterals in D 2.1 and D 3.1, thus the zero scores for the relevant level descriptors and sample learner responses. It also fails to compare a square and a rectangle, and a square and a rhombus in D 1.1 and D 1.2 respectively, both leading to zero scores for each. Its total score of 1.00 for the series is a 20% compliance with the Van Hiele level 1 descriptor-learner responses of the logical skills in this grade 6 textbook series.

Series 4 has zero scores for not comparing the square and rhombus in D 1.2 and failing to sort quadrilaterals into kites and non-kites in D 3.1. Furthermore, it only neglects to sort quadrilateral according to pairs of parallel sides in D 2.1, hence the loss of 1/4 (0.25) score. Its total score of 2.75 for the series is a 55% compliance with the Van Hiele level 1 descriptor-learner responses of the logical skills in this grade 6 textbook series.

Series 5 neglects to sort quadrilaterals in D 2.1 and D 3.1, thus the zero scores for the relevant level descriptors and sample learner responses. Its highest total score of 3.00 for the series is a 60% compliance with the Van Hiele level 1 descriptor-learner responses of the logical skills in this grade 6 textbook series.

4.5.1.3.5 Applied skills score (Possible: 8.00)

The following are the results of the evaluation based on Appendix I and the specific Van Hiele level 1 descriptor-learner response activities E 1.1 - 1.2, E 2.1 - 2.2, E 3.1 - 3.3 and E 4.1. The abbreviated version of these results is section E of Table 4.11 above and the full version is in Appendix I. All the level 1 descriptor-learner activities not allocated a perfect score of 1 lacked the applied skills of the 2-D shapes as given below.

Series 2 and 4 neglect all four level descriptors and accompanying sample learner responses in E 1.1 - 1.2, E 2.1 - 2.2, E 3.1 - 3.3 and E 4.1, thus scoring zero on all of them as indicated

in Appendix I. The total score of 0.00 for each series of textbook is a 0.00% compliance with the Van Hiele level 1 descriptor-learner responses of the applied skills in this grade 6 textbook series.

Series 1 does not include the opposite and parallel sides of the rhombus in E 4.1, thus scoring 1/3 (0.33) less. Before the A 4.1 level descriptor and sample learner response, series 1, similar to series 2 and 4 also neglected all the first three level descriptors and accompanying sample learner responses in E 1.1 - 1.2, E 2.1 - 2.2 and E 3.1 - 3.3, thus scoring zero on all of them as indicated in Appendix I. Its total score of 0.67 is an 8% compliance with the Van Hiele level 1 descriptor-learner responses of the applied skills in this grade 6 textbook series.

Series 3 does not include the opposite and parallel sides of the square and rhombus in E 4.1, thus scoring 2/3 (0.67) less. Before the A 4.1 level descriptor and sample learner response, series 1, similar to series 2 and 4 also neglects all the first three level descriptors and accompanying sample learner responses in E 1.1 - 1.2, E 2.1 - 2.2 and E 3.1 - 3.3, thus scoring zero on all of them as indicated in Appendix I. Its total score of 0.33 is a 4% compliance with the Van Hiele level 1 descriptor-learner responses of the applied skills in this grade 6 textbook series.

Series 5 does not include the opposite and parallel sides of the square in E 4.1, thus scoring 1/3 (0.33) less. Before the A 4.1 level descriptor and sample learner response, series 1, similar to series 2 and 4 also neglected all the first three level descriptors and accompanying sample learner responses in E 1.1 - 1.2, E 2.1 - 2.2 and E 3.1 - 3.3, thus scoring zero on all of them as indicated in Appendix I. Its total score of 0.67 is an 8% compliance with the Van Hiele level 1 descriptor-learner responses of the applied skills in this grade 6 textbook series.

4.6 CONCLUSION OF RESULTS

Sections 4.3, 4.4, 4.5 of this Chapter 4, in conjunction with the relevant sub-sections, presented the results of the evaluation of five of the eight approved grades 4 - 6 Mathematics (English LOLT) textbooks, based on the four criteria of curriculum content, content analysis, teaching and learning design and appropriate English LOLT level are presented.

Firstly, the results of the appropriate English LOLT level for grades 4 - 6 at the age group levels of 10 - 12 years were presented as the readability and specifically the level of ease of reading and understanding of the text in each textbook. Presented in tables 4.1 – 4.3, the results are presented for each grade and textbook series by means of the Gunning Fog

Readability Indices (GFRIs). Secondly, the curriculum content results presenting the level and amount of curriculum content alignment with the grades 4 - 6 CAPS document are presented through tables 4.4 – 4.8. Third and lastly, the content analysis results presenting the pedagogical approach as well as the teaching and learning (instructional) design of the Van Hiele Theory of Geometric Thought are presented through tables 4.9 – 4.11. The summary of the results and findings, the conclusions and recommendations based on them are presented in Chapter 5.

CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 OVERVIEW OF THE STUDY

The aim of this study was to investigate the contribution of grades 4 - 6 Mathematics (English LOLT) learner textbooks towards the development of conceptual understanding of 2-D shapes. In order to establish the contribution of the textbooks as described in the aim and title of the research, a review of relevant literature concerning textbooks, the English medium language of learning and teaching (instruction) as well as the curriculum was conducted. The curriculum model of the intended, potentially implemented, implemented and attained curriculum postulated by Johansson (see 2.2.2.1) was selected as a theoretical framework to inform the study. Other literature was used to augment concepts implicit in certain characteristics of the model. In particular, the terms of reference by which the grades 4 - 6 Mathematics textbooks were submitted for evaluation and adoption in the national catalogue, the language readability of the English text in the grade 4 - 6 series of textbooks and the Van Hiele Theory of Geometric Thought were used. The Van Hiele theory can be said to have operated as the second theoretical framework.

The nature, the elements and the practice of curriculum, the Mathematics textbooks and curriculum implementation were discussed at length. The contribution of the grades 4 - 6 Mathematics learner textbooks towards the development of the conceptual understanding of 2-D shapes was then evaluated with the use of three measuring instruments, namely, the Gunning Fog Readability Test (GFRT), the CAPS-based and the Van Hiele theory-based instruments. The results of the evaluations done through the three instruments provided the conclusions of the contribution of the grades 4 - 6 textbooks towards the development of the conceptual understanding of 2-D shapes.

5.2 SUMMARY OF THE FINDINGS

5.2.1 Objective 1:

Describe the readability of a series of five grades 4 - 6 Mathematics (English LOLT) textbooks evaluated and adopted into the national catalogue, with respect to the topics, concepts and skills of 2-D shapes. In other words, are the textbooks readable with ease and understanding for the grades and years of education of the learners in each of the grades 4 - 6, with regard to the topics, concepts and skills of 2-D shapes?

The readability of the five series of grades 4 - 6 textbooks is the indication of the number of years of education that each of the grades 4 - 6 Mathematics learners needs to be able to understand the texts easily on the first reading (see 2.2.3.3). It forms part of 'how' as an element of the intended curriculum the textbooks can and should contribute towards the development of conceptual understanding of 2-D shapes by being consistently readable at the appropriate level and grade for the learners. It is the first evaluation conducted by the researcher to determine whether the textbooks contribute to the development of conceptual understanding of 2-D shapes or not.

Based on the presentations, interpretations and analysis of the results of the readability of the 15 grades 4 - 6 textbooks, the following findings were made:

5.2.1.1 Only one series of textbooks per grade is readable with ease and understanding and contributes towards the development of conceptual understanding of the topics, concepts and skills of 2-D shapes. (see 4.3.2 and 4.3.3; table 4.1 – 4.3, Appendix A).

Series 2 among the grade 4 Mathematics textbooks, with two GFRIs of 3.57 and 3.76, which are within the grade 4 appropriate GFRI range of 3.00 - 4.00, is readable with ease and understanding for the grade 4 learners in the age groups around 10 years old. This series 2 contributes towards the development of conceptual understanding of 2-D shapes.

Series 5 among the grade 5 Mathematics textbooks, with two GFRIs of 4.06 and 4.77, which are within the grade 5 appropriate GFRI range of 4.00 - 5.00, is readable with ease and understanding for the grade 5 learners in the age groups around 11 years old. This series 5 contributes towards the development of conceptual understanding of 2-D shapes.

Series 3 among the grade 6 Mathematics textbooks, with two GFRIs of 4.82 and 2.24, which are within the grade 6 possible and acceptable GFRI range of 0.01 - 6.00, is readable with ease and understanding for the grade 6 learners in the age groups around 12 years old. This series 3 contributes towards the development of conceptual understanding of 2-D shapes.

The other series of textbooks were determined not to be readable with ease and understanding, viz. series 1, 3, 4 and 5 in grade 4; series 1, 2, 3 and 4 in grade 5 and series 1, 2, 4 and 5 in grade 6 cannot contribute to the development of conceptual understanding of 2-D shapes. The two main reasons for their non-contribution are either that they cannot consistently be read with ease and understanding because of the inconsistent GFRIs

obtained, or cannot at all be read with ease and understanding because both GFRIs were higher than the appropriate GFRI range.

5.2.1.2 All the five series of textbooks lack consistency of ease of reading with understanding across all three grades 4, 5, 6 in the intermediate phase because the results indicate three different series of textbooks readable with ease for grade 4, 5 and 6 respectively, and no series consistent in two or all three grades.

Series 2, determined to be readable with ease and understanding for the grade 4 learners in age group around 10 years old, has been determined not readable with ease and understanding in grades 5 and 6 because of inconsistent readability.

Series 5, determined to be readable with ease and understanding for the grade 5 learners in age group around 11 years old, has been determined not readable with ease and understanding in grades 4 and 6 because of inconsistent readability and higher readability respectively.

Series 3, determined to be readable with ease and understanding for the grade 6 learners in age groups around 12 years old, has been determined not readable with ease and understanding in grades 4 and 5 because of inconsistent readability.

Series 1 has been determined not readable with ease and understanding for all three grades 4, 5 and 6 learners in age groups 10 - 12 years old, because of inconsistent readability in grade 4 and because of higher readability in both grades 5 and 6.

Series 4 has been determined not readable with ease and understanding for all three grades 4, 5 and 6 learners in age groups 10 - 12 years old, because of inconsistent readability in grade 6 and because of higher readability in both grades 4 and 5.

5.2.1.3 There is a possibility that even series 2, 5 and 3 which were determined to be readable with ease and understanding in grades 4, 5 and 6 respectively, on the basis of only two GFRIs, might be determined otherwise if more than just two GFRIs were determined per textbook. This underscores the importance of textbooks being consistently readable with ease and understanding through out all the pages and in all contexts, content and text in them. This is true even for the activities, exercises and explanations contained in each and everyone of them.

5.2.1.4 It is ideal for a textbook to consistently have GFRIs which are lower than those required for the age and school grade of its intended learners rather than have GFRIs which are inconsistent. A mixture of consistently lower GFRIs and those that are consistently at the correct level is the ideal and will ensure that the textbook is at all stages, concepts, topics and skills readable with ease and understanding.

5.2.2 Objective 2:

Describe the progression of the topics, concepts and skills of 2-D shapes in the grade 4 textbooks from grade 3. In other words, do the beginning of the intermediate phase grade 4 textbooks show progression from grade 3 in the topics, concepts and skills of 2-D shapes as given in the CAPS for grade 3?

The progression of the topics, concepts and skills of 2-D shapes from grade 3 to grade 4 contributes towards the development of conceptual understanding of 2-D shapes in grade 4 and beyond (see 4.4.4.1.6).

The five series of grade 4 textbooks demonstrated a high CAPS progression compliance level of the topics, concepts and skills of 2-D shapes from grade 3 to 4, ranging from 67% to 73% and averaging 69% (see table 4.4). The high progression with a variation of 6% between the lowest and highest progression level, can also be termed revision. It implies that only 27% to 33% of the topics, concepts, and skills of 2-D shapes covered in the grade 4 textbooks are not progression from grade 3, but are instead entirely new to grade 4. The variation of 6% in the progression level of the five textbooks is also remarkable and demonstrates an almost equal progression and compliance of the five series of textbooks.

An even higher grade 4 CAPS compliance level of 82 - 96%, averaging 90%, of the same grade 4 textbooks on the topics, concepts and skills of 2-D shapes, demonstrates that even more grade 4 Mathematics topics, concepts and skills were implemented and complied with as compared to grade 3 CAPS progression (table 4.5). Hence, the findings are as follows:

5.2.2.1 There is more than enough CAPS progression from grade 3 to grade 4 for the topics, concepts and skills related to 2-D shapes in the grade 4 textbooks. In fact, a uniform CAPS progression of 50% (reduction of 17% to 23%) of grade 3 into grade 4 would be best to allow for full grade 4 CAPS compliance instead of one with a deficit of 4% to 18%.This means that the grade 3 CAPS progression compliance to grade 4 must not be done at the expense of the grade 4 CAPS compliance of the textbooks.

5.2.2.2 The variation of 6% in the grade 4 CAPS progression compliance levels from grade 3 to 4 is remarkable and is almost as good as equal compliance. A lower variation of not more that 2% is desirable and more acceptable.

5.2.3 Objective 3:

Describe the CAPS compliance of the grades 4 - 6 textbooks in terms of the topics, concepts and skills of 2-D shapes, including teaching guidelines of each grade in each textbook. In other words, are the presentations, explanations, diagrams, teaching and learning exercises and activities in the textbooks compliant with topics, concepts and skills in the CAPS for each specific grade 4 - 6?

For a full grade 4, 5 or 6 Mathematics CAPS compliance of any textbook, all the teaching-learning activities, and thus all the geometric skills in appendices B, C and D must be 100% complied with. One specific condition must be satisfied for full 100% CAPS compliance, namely, that the presentations, explanations, diagrams, teaching and learning exercises and activities in the textbooks must be compliant with all topics, concepts and skills in the CAPS for each specific grade 4, 5 and 6. As a result, the teaching-learning activities in appendices B, C and D should core the maximum score of 1. Consequently, all the skills scores of the textbooks should score the possible maximum scores reflected at the end of every skill in tables 4.3, 4.4, 4.5 and all the total scores of all the series of textbooks should be equal to the possible total scores in tables 4.3, 4.4, 4.5.

The results of the CAPS compliance of the grade 4, 5 and 6 series of textbooks in tables 4.5, 4.6, 4.7 and Appendices B, C and D, revealed different levels of CAPS compliance by all five textbooks within a grade and all fifteen textbooks across grades 4, 5 and 6. The following findings are derived from the nature and level of CAPS compliance of the textbooks:

5.2.3.1 All five series of grade 4, all five series of grade 5 and all five series of grade 6 textbooks fail to fully implement the CAPS in the relevant grades and are thus not CAPS compliant. They all do not contribute to the development of the conceptual understanding of 2-D shapes. Lack of compliance robs development instead of contributing to it.

5.2.3.2 The variation levels of 14%, 13% and 11% in CAPS compliance of the grade 4, 5 and 6 textbooks respectively, between the five series of textbook is too high.

The CAPS compliance levels of the grade 4 series of textbooks demonstrate different levels of overall implementation of the grade 4 CAPS topics, concepts and skills of 2-D shapes. With variation levels from 82% to 96% and averaging 90%, even though high, the implementation is not 100% CAPS compliant as it should be. At the indicated levels, the implementation of the textbooks is partial and incomplete since not all teaching-learning activities and skills are fully complied with. The implementation is also highly unequal with a variation of 14% between the lowest and highest compliance levels of the five series textbooks.

The 4% to 18% deficit in CAPS compliance levels represents the amount of topics, concepts and skills that have not been implemented and are lacking in the textbooks as well as the unequal implementation and compliance among the five series of textbooks. Thus, the five series of grade 4 textbooks evaluated, have failed to correctly, consistently and fully interpret the intended curriculum of grade 4 Mathematics concerning topics, concepts and skills of 2-D shapes. All of them do not contribute to the development of the conceptual understanding of 2-D shapes. Lack of compliance robs development instead of contributing to it.

Varying from 83% to 96% and averaging 92%, the CAPS compliance of the five grade 5 series of textbooks also demonstrates different levels of overall implementation and compliance of the grade 5 CAPS topics, concepts and skills of 2-D shapes. This is an implementation and compliance level that is slightly higher than that of the grade 4 series of textbooks, but is also not 100% CAPS compliant as it should be. With a variation of 13% between the lowest and highest compliance levels of the five series textbooks, the implementation of the textbooks is highly unequal, partial and incomplete as well. Not all the teaching-learning activities and skills are fully complied with.

The 4% to 17% deficit in CAPS compliance represents the amount of topics, concepts and skills that have not been implemented and are lacking in the textbooks, and also demonstrates the unequal implementation and compliance amongs the five series of textbooks. Therefore, the five series of grade 5 textbooks evaluated, failed to correctly, consistently and fully interpret the intended curriculum of grade 5 Mathematics concerning topics, concepts and skills of 2-D shapes. They all do not contribute to the development of the conceptual understanding of 2-D shapes. Lack of compliance robs development instead of contributing to it.

Varying from 84% to 95% and averaging 89%, the CAPS compliance levels of the grade 6 series of textbooks is also higher than that of grade 4. However, it is also not the 100%

CAPS compliance required; it is partial and incomplete since not all teaching-learning activities and skills are fully complied with. With a variation of 11% between the lowest and highest compliance levels of the five series textbooks, the compliance of the textbooks is highly unequal as well. The 5% to 16% deficit CAPS compliance levels represents the amount of topics, concepts and skills that have not been implemented and are lacking in the textbooks and also demonstrates the unequal implementation and compliance. Therefore, the five series of grade 6 textbooks evaluated, have all failed to correctly, consistently and fully interpret the intended curriculum of grade 6 Mathematics concerning topics, concepts and skills of 2-D shapes. They all do not contribute to the development of the conceptual understanding of 2-D shapes. Lack of compliance robs development instead of contributing to it.

5.2.3.3 The failure of the five grades 4 - 6 textbooks to correctly interpret and fully implement the CAPS in the relevant grades creates gaps in conceptual knowledge and understanding in textbooks, teachers and learners.

The lack of 100% CAPS compliance to all the teaching-learning activities specified in Appendices B, C and D means that important conceptual knowledge and understanding as specified by the topics, concepts and skills of 2-D shapes in the grade 4 - 6 CAPS is lacking in all the five series of textbooks of all the three grades 4, 5 and 6.The lacking conceptual knowledge and understanding creates conceptual knowledge and understanding gaps not only in each textbook, but also in the teachers' and learners' knowledge system about 2-D shapes. The lack of full compliance, resulting in conceptual knowledge and understanding gaps in grades 4, 5 and 6 textbooks cannot contribute towards the development of conceptual understanding of 2-D shapes. The requirement is full contribution through full CAPS compliance.

5.2.3.4 The failure of the five grades 4 - 6 textbooks to correctly interpret and fully implement the CAPS in the relevant grades implies different and unequal service delivery by the textbooks.

Over and above the lack of full compliance; the resulting gaps in conceptual knowledge and understanding, the different levels of implementation and compliance in grades 4, 5 and 6 textbooks results in different and unequal service delivery by the five series of textbooks. This is because a textbook at 80% compliance would most likely have covered fewer topics, concepts and / or skills as compared to one at 95%.

5.2.4 Objective 4:

Describe the progression of the topics, concepts and skills of 2-D shapes in the grade 6 textbook towards grade 7. In other words, does the end of the intermediate phase grade 6 series of textbooks show progression towards grade 7 in the topics, concepts and skills of 2-D shapes as given in the CAPS for grade 7?

The amount of the grade 7 topics, concepts and skills in the grade 6 textbooks is an indication of the extent of progression and link between the lower grade 6 and higher grade 7 (see 4.4.4.5.6). The progression of the topics, concepts and skills of 2-D shapes from grade 6 to grade 7 contributes towards the development of conceptual understanding of 2-D shapes not only in grade 7, but also in grade 6 as well. The progression forms a link between grades 6 and 7 in a forward and reverse manner (see 4.4.4.5.6).

All five grade 6 textbooks of series 1-5 demonstrate a just below average progression and CAPS compliance of 37% of all the skills according to sections A - E, as can be seen in table 4.8. Specifically, the amount of progression and CAPS compliance in series 1 - 5 of the grade 6 textbooks ranges from 25% to 43%. There is a high variation of 18% between the textbooks with the lowest and highest compliance levels and the following finding was made:

5.2.4.1 There is a less than 50%, unequal, widely varying CAPS progression compliance of the grade 7 topics, concepts and skills in the grade 6 textbooks.

5.2.5 Objective 5:

Describe the Van Hiele levels 0 and 1 compliance of the series of five grades 4 - 6 textbooks, in terms of the level descriptors and learner responses. In other words, are the presentations, explanations, diagrams, teaching and learning exercises and activities in the textbooks congruent with the developmental path of the van Hiele theory of geometric development regarding levels 0 and 1?

The results of the Van Hiele level 0 descriptors' compliance in Appendix G and Table 4.9 for the grade 4 series of textbooks indicate Van Hiele level 0 compliance levels varying from 42% to 50% and averaging 47%. The compliance levels are different, unequal and partial, with a variation of 8% between the lowest and highest compliance level. From the compliance levels, which are no-where near 100%, it is evident that the Van Hiele level 0 descriptors and learner responses are not complied with by the five grade 4 series of textbooks, hence none of the textbooks can support learners to achieve Van Hiele level 0. All of the five grade 4 textbooks fail to enable learners to identify and operate on 2-D shapes

and other geometric configurations according to their appearance (4.5.4.1.6). The following finding was made:

5.2.5.1 The van Hiele level 0 is not achieved at the end of grade 4 of the five series of grade 4 textbooks. This suggest that the Van Hiele Theory of Geometric Thought might not be an element of the South African Mathematics curriculum (see 2.2.3.2; 2.2.3.4)

The results of the Van Hiele level 1 compliance in Appendix H and Table 4.10 for the grade 5 series of textbooks indicate Van Hiele level 1 compliance levels varying from 8% - 25% and averaging 19%.The compliance levels are different, unequal and partial, with a variation of 17% between the lowest and highest compliance level. The compliance levels are far from 100%, thus not van Hiele level 1 compliant. This implies that all of the five grade 5 textbooks cannot support the learner to achieve the Van Hiele level 1 at grade 5. However, the five textbooks do begin to enable learners to analyse figures in terms of their components and relationships between components, establish properties of a class of figures empirically and use properties to solve problems (4.5.4.2.6).

The results of Van Hiele level 1 compliance in Appendix I and Table 4.11 for the grade 6 series of textbooks also indicate different Van Hiele level 1 compliance levels, varying from 20% - 42% and averaging 30%. With a variation of 22%, the compliance levels are also highly unequal and partial. None of the textbooks achieve the 100% compliance; none of them can support learners to achieve Van Hiele level 1 at grade 6 level. However, the increased compliance levels from grade 5 is an indication of the five grade 6 textbooks continuing to enable learners to analyse figures in terms of their components and relationships between components, establish properties of a class of figures empirically and use properties to solve problems (4.5.4.3.6). The following finding was made:

5.2.5.2 The non-compliance of the five grade 6 series of textbooks with the Van Hiele level 1 implies that the world renowned theory of geometric thought is not an element of the South African Mathematics curriculum. Van Hiele level 1 is not achieved at the end of any of the grade 6 textbooks (see 2.2.3.2; 2.2.3.4).

5.3 REFLECTIONS AND DISCUSSIONS

5.3.1 Reflection of the theoretical framework

The theoretical framework that informed this study was based on the curriculum model of the intended, potentially implemented, implemented and attained curriculum postulated by Johansson (see 2.2.2.1). The model is similar to the one presented by Stein (2007: 321) and

was chosen as a result of the pertinent focus the researcher wanted to put on the textbooks and their role. As the tools for interpreting and delivering the topics, concepts and skills of 2-D shapes expressed in the intended curriculum, the CAPS (see 1.1; 2.3.2), good quality textbooks are seen as pivotal for the delivery of a quality, credible, efficient and effective education system comparable to those of other countries. Provision of good quality textbooks is an automatic second step after strengthening the intended curriculum, but a first step in propagating the policy statement for learning and teaching and bringing confidence to the classroom and the school.

5.4 CONCLUSIONS AND RECOMMENDATIONS

5.4.1 The readability measure

5.4.1.1 Conclusions

- The GFRIs results indicate that only series 2 in grade 4, series 5 in grade 5 and series 3 in grade 6 are readable with ease and understanding as required. This means only one out of five grade 4 textbooks, one out of five grade 5 and one out of five grade 6 Mathematics (English LOLT) textbooks evaluated by the GFRT are readable with ease and understanding. This translates to only 20% of textbooks in each grade and overall 20% of the 15 grades 4-6 textbooks evaluated. Only the 20% of the textbooks that are readable with ease and understanding contribute towards the development of the conceptual understanding of 2-D shapes with regard to the level of the English LOLT readability.

5.4.1.2 Recommendations

- That the readability of every Grades R - 12 textbook evaluated for approval and adoption into the national catalogue be evaluated by making use of one or more readability measuring instruments to ensure correct, consistent and appropriate language level for the grade and age group of the learners;

- That at least 3 GFRIs (or any other readability measuring test) per topic and at least 15 GFRIs (or any other readability measuring test) per textbook be determined for consistency of readability. Where possible, the whole textbook can be tested for the correct, consistent and appropriate language level for the grade and age group of the learners;

- That a special South African English LOLT readability test and formula be developed at first additional language levels for all appropriate grades. This will ensure that the English LOLT level is prioritised for the majority of the South African learners, for

whom English is a first additional language. The developed readability test and formula would then be made available to all authors and publishers as one of the terms and conditions that all Grades R – 12 textbooks must satisfy for approval and inclusion in the national catalogue.

5.4.2 CAPS compliance measure

5.4.2.1 Conclusions

- The 67% to 73% CAPS progression compliance of the grade 4 textbooks from grade 3, averaging 69%, with a variation of 6% between the between the lowest and highest progression level is more than enough (table 4.4);

- Even though the grades 4 – 6 CAPS compliance levels are high at 82% - 96%, average of 90% and variation of 14% for grade 4; 83% - 96%, average of 92% and variation of 13% for grade 5; 84% to 95%, average 89% and variation of 11% for grade 6 textbooks, they are still not the full, complete and 100% compliance levels required for the topics, concepts and skills of 2-D shapes. The determined compliance levels do not only fall short of the required levels of 100% standards and norms, but the variations of 14%, 13% and 11% between the lowest and highest progression levels of grades 4 – 6 textbooks are considered too high by the researcher. Variation levels of less than 2% are ideal and show more consistency.

- The grade 6 to 7 CAPS progression compliance levels of 25% - 43%, averaging 37%, with a variation of 18% between the between the lowest and highest progression level, is too low. This is especially in comparison to the more than 60% progression compliance from grade 3 to grade 4 indicated by the textbooks in objective 2 and finding 5.2.2.1. A 50% progression, with a much smaller variation level of 2% or less between the textbooks seems more appropriate.

5.4.2.2 Recommendations

It is recommended that the Department of Basic Education design and set up much more methodical, in-depth and stringent evaluation processes for all textbooks of all grades, specifically according to the topics, concepts and skills in the CAPS documents. The textbooks should be scored on specific topics, concepts and skills and not in general terms to ensure that only 100% CAPS compliant textbooks are adopted into the national catalogue. The following specifications must apply:

- There must be a specific stipulated minimum CAPS progression level in percentage set and measured between any two consecutive grades as part of the standards and norms of CAPS progression. This can be achieved for every topic, concept and skill level and ultimately for the whole grade and phase.

- All textbooks of all grades must be specifically evaluated on the topics, concepts and skills of the specific grade and must be 100% compliant with regard to the individual and overall consideration. Different compliance sheets per topic, concept and skill, similar to Appendices B – F, can be designed and used during the evaluation and approval of the textbooks. The same CAPS compliance sheets can and should be made available to authors and publishers to gauge their textbooks while writing and before submission for evaluation and approval.

Further recommendation is that all the textbooks that are currently on the national catalogue must be re-evaluated according to a procedure similar to the research and recommended above. The re-evaluation can take place before the three year period of adoption into the national catalogue expires or it can commence with the new round of evaluations for the adoption and inclusion in the catalogue for another three year period.

5.4.3 Van Hiele levels 0 and 1 compliance measure

5.4.3.1 Van Hiele level 0 conclusion

The Van Hiele level 0 is not achieved at the South African grade 4 level of the five series of textbooks in the study because the appropriate level 0 descriptors and learner responses are not fully complied with. This suggests that the Van Hiele level 0 is either achieved at the end of grade 3 of the five series of textbooks evaluated or it is never achieved at all in any one particular grade.

5.4.3.2 Van Hiele level 0 recommendation

The recommendation is that the Van Hiele Geometric Theory of Thought and similar world renowned mathematical theories be incorporated into the South African Mathematics curriculum policies, practice and research as part of strengthening the South African Mathematics education. This means that the Van Hiele Theory in its entirety must be implemented from grades R – 12 in all geometry textbooks and classroom activities to increase the the effectiveness of geometry education.

5.4.3.3 Van Hiele level 1 conclusions

Van Hiele level 1 is not achieved at the South African grade 5 level of the five series of textbooks in the study because the appropriate level 1 descriptors and learner responses are not fully complied with. It is acceptable and appropriate that the series of grade 5 textbooks evaluated are not fully equipped with the necessary descriptor-learner responses for achieving the Van Hiele level 1 at grade 5.

Van Hiele level 1 is not achieved at the South African grade 6 level of the five series of textbooks in the study because the appropriate level 1 descriptors and learner responses are not fully complied with. This suggests that the Van Hiele level 1 is either achieved at the end of a higher grade 7 or 8 of the five series of textbooks evaluated or it is never achieved at all in any one particular grade.

5.4.3.4 Van Hiele level 1 recommendation

The recommendation is that the Van Hiele geometric theory of thought and similar world renowned mathematical theories be incorporated into the South African Mathematics curriculum policies, practice and research as part of strengthening the South African Mathematics education. This means that the Van Hiele Theory in its entirety must be implemented from grades R – 12 in all geometry textbooks and classroom activities to increase the the effectiveness of geometry education.

5.5 IMPLICATIONS OF THE STUDY

This study was limited to the content area of shape and space (geometry), and topics, concepts and skills of 2-D shapes, but carries implications in terms of policy and practice as a whole, as well as research. Its implications are as follows:

5.5.1 That grades 4 - 6 teachers, who are currently implementing the CAPS through the use of the textbooks in the study, can be approached by means of a questionnaire, interviews or both in order to determine their evaluation of these textbooks. The following could be the objectives:

- To establish the criteria and / or reason/s they had to choose the textbooks;
- To determine how they rate the textbooks now after having implemented with them for a year or more;
- To determine what their evaluation is of the textbooks with regard to whether the textbooks contribute towards the development of the conceptual understanding of 2-D shapes;

- To establish whether the grades 4 - 6 teachers who are currently using the textbooks in the study are simultaneously also using supplementary textbook(s) or not. Both responses of yes or no must be followed up with questions of why yes and why no, reflecting on the contents of the textbooks and/or classroom teaching-learning practices of the teacher.

5.5.2 That both the publishers and the DBE can be approached with the results of the research to start a conversation meant to enrich all the parties, namely, the research process, writing and publication as well as evaluation and adoption of textbooks.

5.5.3 That research must be continually done on all the approved textbooks from grade R - 12 and the workbooks of the DBE to identify strengths and weaknesses that should be used to strengthen the quality and credibility of the textbooks.

5.5.4 That, through the feedback and inputs from different researchers and practitioners, the DBE must continually improve its evaluation form and processes in pursuit of quality and credible Mathematics textbooks that correctly interpret and give full meaning to all the topics, concepts and skills in the CAPS.

5.5.5 That the non-compliance of the grade 6 series of textbooks with the Van Hiele level 1 implies that this world-renowned Theory of Geometric Thought, unlike the general and specific content foci, is not one of the elements of the South African Mathematics curriculum (see 2.2.3.2; 2.2.3.4). Similar to the grade 4 textbooks that were determined not to be Van Hiele level 0 compliant, it is likely that the grade 7 and even grade 8 textbooks will not be compliant either;

5.5.6 That the authors and publishers of the five series grades 4 - 6 textbooks evaluated did not thoroughly study, understand, interpret and implement the relevant topics, concepts and skills of 2-D shapes as indicated in the specification of content and teaching guidelines of the CAPS;

5.6 FINAL WORD AND ANALYSIS

The research findings in this Chapter 5 based on the results and analysis in Chapter 4, strongly support the conclusions of Johansson (see 2.2.3.4). There is indeed agreement between the objectives of Mathematics and specifically the topics, concepts and skills of 2-D shapes as explicitly stated in the grade 4 – 6 CAPS document and the content of the 15 grades 4 – 6 textbooks. However, the agreement is not full and / or complete, neither is it

uniform within a textbook or series of textbooks, and thus falls short when measured by readability, CAPS-based and Van Hiele-based tools developed and used as provided. Hence, in general, the grades 4 - 6 textbooks do not always and closely follow the guidelines, directives and dictates of the intended curriculum. Consequently, the five series of textbooks and by implication, all the mathematics textbooks as tools, do not interpret and give full, accurate and uniform meaning to not only the shape and space content areas and foci, but all the five mathematics content areas and foci.

Without being readable with ease and understanding at the appropriate level; without interpreting and giving full, accurate and uniform meaning to the Mathematics content area and foci, and without incorporating the world-wide renown Van Hiele Theory, our South African Mathematics learner textbooks might not be the proper tools for facilitating and developing meaningful mathematical understanding. These findings point to the potentially implemented curriculum, specifically textbooks, in the curriculum model of Johansson (2005b: 120), not effectively and sufficiently fulfilling their role, and contradict the results of the evaluation and approval of the textbooks into the national catalogue. They beg for a more thorough and quality driven evaluation process to complement the new NCS Grades R – 12, the ANA process and all the initiatives supporting the SMT and teachers in the classroom in order to bring about the better outcomes of the attained curriculum.

REFERENCE LIST

Begeny J.C. & Green D.J. 2014. Can readability formulas be used to successfully gauge difficulty of reading materials? Psychology in the schools, 51 (2): 198 – 215.

Beinstein, A., McCarthy, J. & Oliphant, R. 2013a. Maths outcomes in South African schools. What are the facts? What should be done? Johannesburg: Centre for Development and Enterprise.

Beinstein, A., McCarthy, J. & Oliphant, R. 2013b. Maths teaching in South Africa adds up to multiplying class divisions. Mail & Guardian: 24 Oct. http://mg.co.za/article/2013-10-24-maths-teaching-in-sa-adds-up-to-multiplying-class-divisions. Date of access: 11 January 2013.

Burns, R. & Charleston, R. 1997. The readability of English medium curriculum texts in Brunei primary schools. Australian journal of language and literacy, 20 (4): 290 - 302.

Cangelosi, J.S. 2007. Teaching mathematics in secondary and middle schools: an interactive approach. 3rd ed. Upper Saddle River, N.J.: Pearson Education.

Clements, D.H. 2004. Perspective on "The child's thought and geometry". (*In* Carpenter, T.P., Dossey, J.A. & Koehler, J.L., *eds*. Classics in mathematics education research. Reston, Va.: National Council of Teachers of Mathematics (NCTM). p 60 – 66.)

Creswell, J.W. 2009. Research design: qualitative, quantitative and mixed methods approaches. 3rd ed. Los Angeles, Calif.: Sage.

Crowley, M.L. 1987. The Van Hiele model of the development of geometric thought. (*In* Lindquist, M.M & Schulte, A.P., *eds*. Learning and teaching geometry K – 12. Reston, Va.: National Council of Teachers of Mathematics (NCTM). P 1-16.)

Davey, G. & Holliday, J.1992. Van Hiele guidelines for geometry. The Australian mathematics teacher, 48 (2): 26 - 29.

Dillon, J.T. 2009. The question of curriculum. Journal of curriculum studies, 41 (3): 343 - 359.

Dossey, J.A., McCroney, S., Giordano, F.R. & Weir, M.D. 2002. Mathematics methods and modelling for today's mathematics classroom: a contemporary approach to teaching grades 7 – 12. Pacific Grove, Calif.: Brooks / Cole.

Fuys, D., Geddes, D. &Tischler, R. 1988. The Van Hiele model of thinking in geometry among adolescents. Reston, Va.: National Council of Teachers of Mathematics (NCTM). (Journal for research in mathematics education, Monograph number, v 3, p. 58 – 63)

Gawe, N., Jacobs, M. &Vakalisa, N.C.G. 2011. Learner-centred methods. (*In* Jacobs, M., Vakalisa, N.C.G & Gawe, N., *eds*.Teaching and learning dynamics. 4thed. Cape Town: Pearson Education South Africa. p. 186 – 213.)

Gunning, R. 1952. The technique of clear writing. New York: McGraw-Hill.

Hierbert , J. & Grouws, D.A. 2007. The effects of classroom mathematics teaching on students' learning. (*In* Lester F.K., Jr., *ed*. Second handbook of research on mathematics teaching and learning. Charlotte, NC: Information Age Publishing. p. 371 – 401.)

Hoffer, A. 1981. Geometry is more than just proof. Mathematics teacher, 74: 11 - 18.

Jacobs, M. 2011a. Curriculum. (*In* Jacobs, M., Vakalisa, N.C.G & Gawe, N., *eds*. Teaching and learning dynamics. 4th ed. Cape Town: Pearson Education South Africa. p. 31 – 63.)

Jacobs, M. 2011b. Aims and Objectives. (*In* Jacobs, M., Vakalisa, N.C.G & Gawe, N., *eds.* Teaching and learning dynamics. 4th ed. Cape Town: Pearson Education. p. 66 – 94.)

Jacobs, M. 2011c. Teacher-directed methods. (*In* Jacobs, M., Vakalisa, N.C.G & Gawe, N., *ed.* Teaching and learning dynamics. 4thed. Cape Town: Pearson Education South Africa p. 155 – 185.)

Johansson, M. 2005a. The mathematics textbook: from artefat to instrument. Nordic studies in mathematics education (NOMAD), 10 (3 – 4): 43 – 64.

Johansson, M. 2005b. Mathematics textbooks – the link between the intended and the implemented curriculum? (Paper presented at Eight International Conference: The Mathematics Education into the 21st Century. Project: Reform, revolution and paradigm shifts in mathematics education. Johor Bahru, Malaysia.)

Johansson, M. 2006. Teaching Mathematics with textbooks: a classroom and curriculum perspective. Lulea University of Technology, Sweden.(Thesis – D.)

McMillan, J.H. 2000. Educational research: fundamentals for the consumer. 3rd ed. New York: Longman.

Mouton, J. 2001. How to succeed in your master's and doctoral studies: South African guide and resource book. Pretoria: Van Schaik.

Nelson Mandela Metropolitan University. 2007. Study material: concepts of space, shape and measurement (PSMT 211). Port Elizabeth: Nelson Mandela Metropolitan University, Faculty of Education.

Niewenhuis, J. 2010. Qualitative research design and data gathering techniques. (*In* Maree, K., *ed*. First steps in research. Pretoria: Van Schaik. p. 69 – 97.)

Nieuwoudt, H.D. 2006. Approaches to the teaching and learning of Mathematics: an interactive manual for mathematics education students and mathematics educators. Potchefstroom: North West University.

Nieuwoudt, HD. & Nieuwoudt, S. 2011. Curriculum implementation. (*In* Jacobs, M, Vakalisa, N.C.G. & Gawe, N., *eds*. Teaching and learning dynamics. 4th ed. Cape Town: Pearson Education South Africa. p. 309 – 334.)

Nieuwoudt, S. & Reyneke, M. 2011. Assessment. (*In* Jacobs, M, Vakalisa, N.C.G. & Gawe, N., *eds*. Teaching and learning dynamics. 4th ed. Cape Town: Pearson Education South Africa p. 275 – 307.)

Oxford Advanced Learner's Dictionary.2006. International student's edition. 7th ed. Oxford: Oxford University Press.

Presmeg, N. 1991. Applying Van Hiele's theory in senior primary geometry: use of phases between the levels. Pythagoras, 26: 9 - 11.

Reys, B., Reys, R. & Chaves-Lopez, O. 2004. Why mathematics textbooks matter. Educational leadership, 615 (5): 61 - 66.

Robitaile, D. F. & Travers, K. J. 1992. International studies of achievement in mathematics. (*In* Grouws D.A., *ed*. Handbook of research in mathematics teaching and learning. New York: Macmillan. p. 687 – 709.)

South Africa. Department of Education. 2002a. Revised National Curriculum Statement Grades R - 9 (Schools). Overview. Pretoria: Government Printer.

South Africa. Department of Education. 2002b. Revised National Curriculum Statement Grades R - 9 (Schools). Mathematics. Pretoria: Government Printer.

South Africa. Department of Education. 2003a. Revised National Curriculum Statement Grades R - 9 (Schools). Mathematics. Teacher's guide for the development of learning programmes. Pretoria: Government Printer.

South Africa. Department of Education. 2003b. Revised National Curriculum Statement Grades R - 9 (Schools). Natural Science. Teacher's guide for the development of learning programmes. Pretoria: Government Printer.

South Africa. Department of Education. 2007. The Higher Education Qualifications Framework: Higher Education Act, 1997 (Act No. 101 of 1997), Government Notice No. 928. Government Gazette, No. 30353 of 05 September 2007.

South Africa. Department of Basic Education. 2009. The National Senior Certificate: a qualification at Level 4 on the National Qualifications Framework (NQF), Government Notice No. 744,Government Gazette, 481, No. 27819 of 20 July 2005 and amended as: Government Notices 1041 and 1042 in Government Gazette, 533, No. 32678 of 3 November 2009.

South Africa. Department of Basic Education. 2010a. Curriculum news: improving the quality of learning and teaching. Planning for 2010 and beyond.http://www.thutong.doe.gov.za. Date of access: 12 January 2011.

South Africa. Department of Basic Education. 2010b. Statement from the Department of Basic Education: strengthening curriculum implementation from 2010 and beyond. http://www.thutong.doe.gov.za. Date of access: 12 January 2011.

South Africa. Department of Basic Education. 2010c. Statement by the Minister of the Department of Basic Education, Mrs Angie Motshekga, MP on the progress of the review of the National Curriculum Statement, Tuesday 06 July 2010. http://www.thutong.doe.gov.za. Date of access: 28 March 2011.

South Africa. Department of Basic Education. 2011a. Curriculum news: improving the quality of learning and teaching. Strengthening curriculum implementation from 2010 and beyond. May 2011 issue.http://www.thutong.doe.gov.za. Date of access: 27 June 2011.

South Africa. Department of Basic Education. 2011b. Curriculum and Assessment Policy Statement (CAPS) Foundation phase (grades 1 - 3) Mathematics. http://www.thutong.doe.gov.za. Date of access: 22 June 2012.

South Africa. Department of Basic Education. 2011c. Curriculum and Assessment Policy Statement (CAPS) Intermediate phase (grades 4 - 6) Mathematics. http://www.thutong.doe.gov.za. Date of access: 22 June 2012.

South Africa. Department of Basic Education. 2011d. Curriculum and Assessment Policy Statement (CAPS) Senior phase (Grades 7 - 9) Mathematics. http://www.thutong.doe.gov.za. Date of access: 22 June 2012.

South Africa. Department of Basic Education. 2011e. National Policy Pertaining to the Programme and Promotion Requirements of the National Curriculum Statement Grades R – 12. http://www.thutong.doe.gov.za. Date of access: 22 June 2012.

South Africa. Department of Basic Education. 2012a. The 2012 Invitation and Terms of Reference to submit learning and teaching support materials for evaluation and adoption in the national catalogue. http://www.thutong.doe.gov.za. Date of access: 22 June 2012.

South Africa. Department of Basic Education. 2012b. The evaluation form for learning and teaching support materials. (Unpublished.)

South Africa. Department of Basic Education. 2012c. National Catalogues: grade 4 – 6 catalogue. http://www.education.gov.za/LTSM/tabid/645/Default.aspx.Date of access: 22 June 2012.

South Africa. Department of Basic Education. 2012d. Report on the Annual National Assessments 2012: grades 1 to 6 and 9. http://www.education.gov.za. Date of access: 22 June 2012.

Stein, M.K., Remillard, J. & Smith, M.S. 2007. How curriculum influences student learning. (In Lester, F.K. Jr., *ed*. Second handbook of research on mathematics teaching and learning. Charlotte, N.C.: Information Age Publishing. p. 319 – 363.)

Steward, B.J. 2006. A study of the evolution of a physics textbook. Fayetteville, Ariz.: University of Arkansas. (Mini- dissertation – B.Sc Hons.)

Stokes, A. 1978. The reliability of readability formulae. Journal of research in reading, 1: 21 – 34.

Teppo, A. 1991. Van Hiele levels of geometric thought revisited. Mathematics Teacher, 84 (3): 210 - 221.

Trafton, P., Reys, B.J., & Wasman, D. 2001. Standards-based mathematics curriculum materials: a phrase in search of a definition. Phi Delta Kappan, 83, 259 – 264.

Vakalisa, N.C.G. 2011. Participative teaching. (*In* Jacobs, M., Vakalisa, N.C.G. & Gawe, N., *eds*. Teaching and learning dynamics. 4th ed. Cape Town: Pearson Education South Africa. p. 1 - 30).

Vakalisa, N.C.G. & Gawe, N. 2011. Learning content. (*In* Jacobs, M., Vakalisa, N.C.G. & Gawe, N., *eds*. Teaching and learning dynamics. 4th ed. Cape Town: Pearson Education South Africa p. 127 – 153.)

Van De Walle, J. A. 2007. Elementary and middle school mathematics: teaching developmentally. 6th ed. Upper Saddle River, N.J.: Pearson Education.

Van De Walle, J. A., Karp, K.S. & Bay-Williams, J.M. 2013. Elementary and middle school mathematics: teaching developmentally. 8th ed. Upper Saddle River, N.J.: Pearson Education.

Van Hiele, P.M. 1986. Structure and insight: A theory of mathematics education. Florida: Academic Press, Inc.

Van Hiele, P.M. 2004. The child's thought and geometry. (*In* Carpenter, T.P., Dossey, J.A. & Koehler, J.L., *eds.* Classics in mathematics education research.Reston, Va.: National Council of Teachers of Mathematics (NCTM), p 61 - 66.)

Van Rooyen, H. & le Riche van der Merwe, C. 2011. Teaching-learning media. (*In* Jacobs, M., Vakalisa, N.C.G & Gawe, N., *eds*. Teaching and learning dynamics. 4th ed. Cape Town: Pearson Education South Africa. p. 214 – 246.)

Willemse, M.L. 2005. 'n Analise van die "Revised Nationational Curriculum Statement Grades R – 9 (Schools) se meentkunde in die lig van die Van Hiele Model. Ongepubliseerde MEd-proefskrif. Pretoria: Universiteit van Suid-Afrika.

APPENDIX A:

Calculated Gunning Fog Readability Indices (GFRIs) for school grades 4 - 6 of Mathematics learner textbook series 1 - 5

Grade 4 Series GFRI Results for 10 year old learners									
Appropriate GFRI range is of order 3.01 – 4.00 for the Age & School Grade									
Possible & Acceptable GFRI range is of order 0.01 – 4.00 for the Age & School Grade									
S 1		S 2		S 3		S 4		S 5	
6.15	2.51	3.57	3.76	10.57	3.10	5.91	5.85	3.21	5.25
Inconsistent GFRIs (1 GFRI inappropriate)		Consistent GFRIs (Both appropriate)		Inconsistent GFRIs (1 GFRI inappropriate)		Inappropriate GFRIs (Both outside range)		Inconsistent GFRIs (1 GFRI inappropriate)	
Grade 5 Series GFRI Results for 11 year old learners									
Appropriate GFRI range is of order 4.01 – 5.00 for the Age & School Grade									
Possible & Acceptable GFRI range is of order 0.01 – 5.00 for the Age & School Grade									
S 1		S 2		S 3		S 4		S 5	
9.62	6.41	10.08	4.86	2.99	5.96	6.73	10.99	4.06	4.77
Inappropriate GFRIs (Both outside range)		Inconsistent GFRIs (1 GFRI inappropriate)		Inconsistent GFRIs (1 GFRI inappropriate)		Inappropriate GFRIs (Both outside range)		Consistent GFRIs (Both appropriate)	
Grade 6 Series GFRI Results for 12 year old learners									
Appropriate GFRI range is of order 5.01 – 6.00 for the Age & School Grade									
Possible &Acceptable GFRI range is of order 0.01 – 6.00 for the Age & School Grade									
S 1		S 2		S 3		S 4		S 5	
8.56	6.85	6.43	3.71	4.82	2.24	10.61	4.91	6.91	6.43
Inappropriate GFRIs (Both outside range)		Inconsistent GFRIs (1 GFRI inappropriate)		Consistent GFRIs (1 GFRI possible & acceptable, the other		Inconsistent GFRIs (1 GFRI inappropriate)		Inappropriate GFRIs (Both outside range)	

APPENDIX B: Progression compliance from grade 3 to grade 4.

Evaluating the **Grade 4** Mathematics learner textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes

N.B: Appendix is comprised of relavant Grade 3 topics, concepts, skills and clarification notes in the foundation phase Mathematics CAPS document.

SPACE AND SHAPE (Geometry): ▪ General content focus: Properties, relationships, orientations, positions and transformations of 2-D shapes. ▪ Specific content focus: The learner's experience moves from recognition and simple description to classification and more detailed description of characteristics and properties of 2-D shapes. The learner is given opportunities to draw 2-D shapes, describe transformation and symmetry.						
A. VISUAL SKILLS: Recognise, visualise depicted / drawn / written examples						
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 4 SERIES CODING**				
1. The learner recognises 2-D shapes and their properties:		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 circles of *at least two different sizes* (**1/2** per size) **(1)**		1	1	1	1	1
1.2 triangles of *3 different types* according to sides**,** *2 different sizes & positions* per type (1/4 per size, 1/4 per position) **(3)**	**i. Equilateral**: *2 different sizes* **and** *positions* (**1/4** per size, per position) **(1)**	1	2/4	2/4	3/4	2/4
	ii. Isosceles: *2 different sizes **and** positions* (**1/4** per size, per position) **(1)**	1	1	1	1	1
	iii. Scalene: *2 different sizes and positions* (**1/4** per size, per position) **(1)**	1	1	0	1	1
1.3 squares of at least *2 different sizes* placed in at least *2 different positions* (**1/4** per size, position and shape) **(1)**		3/4	1	1	2/4	1
1.4 rectangles of at least *2 different sizes*, placed in at least *2 different positions* (**1/4** per size position and shape) **(1)**		1	1	1	2/4	1
1.5 recognises zero, *single* and *multiple* line symmetry in *geometrical shapes* (**1/3 per aspect**) **(1)**		1	1	1	1	1
1.6 recognises zero, *single* and *multiples line symmetry* in *non-geometrical shapes* (**1/3**) **(1)**		1	2/3	1	1	1
1.7 recognises line of symmetry through paper folding on geometric and / or non-geometric shapes **(1)**		1	1	0	0	0
Total Scores of all activities and aspects: (9.00)		**8.75**	**8.17**	**6.50**	**6.75**	**7.50**
B. VERBAL / WRITTEN SKILLS: Describe, name or identify						
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 4 SERIES CODING**				
1. The learner names / identifies 2-D shapes		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 circles of *2 different sizes* (need not be side by side / next to each other) (**1/2** per size) **(1)**		1	1	1	1	0
1.2 triangles of 3 *different types according to sides, 2 different sizes & positions per type* (1/4 per size, 1/4 per position **(3)**	**i. Equilateral**: *2 different sizes & positions* (**1/4** per size per position)**(1)**	2/4	0	2/4	3/4	2/4
	ii. Isosceles: *2 different sizes & positions* (**1/4** per size per position) **(1)**	2/4	1	1	0	1
	iii. Scalene: *2 different sizes & positions* (**1/4** per size per position) **(1)**	1	1	2/4	1	1

1.3 squares of *2 different sizes*, *placed in 2 different positions* (**1/4** per size per position) **(1)**		3/4	1	1	3/4	3/4
1.4 rectangles of 2 *different sizes*, *placed in different positions* (**1/4** per size per position) **(1)**		1	1	1	1	1
2. The learner describes / identifies 2-D shapes in terms of -		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
2.1 shape (i.e. whether they are circles, triangles, squares or rectangles (identification of them)) **(1)**		1	1	1	1	1
2.2 straight sides (i.e. number of straight sides – triangle, square, rectangle (polygons)) **(1)**		1	1	1	1	1
2.3 round sides (e.g. circle, semi-circle, sector, segment) **(1)**		1	1	1	1	1
2.4 whether they have straight and round sides **(1)**		1	1	1	1	1
3. The learner describes (in words / writing) given simple and complex geometric patterns made with -		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
3.1 physical objects (matches, counters, etc.) **(1)**		1	1	1	1	1
3.2 drawings of lines, shape or objects **(1)**		1	1	1	1	1
4. The learner describes (in own words / writing) simple and complex geometric patterns made with-		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
4.1 physical objects **(1)**		0	0	0	0	1
4.2 drawings of lines, shape or objects **(1)**		0	0	0	0	0
5. The learner describes (in words / writing) own / given geometric patterns all around us		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
5.1 in nature (e.g. honeycombs, etc.): **(1)**		1	1	1	1	0
5.2 from modern everyday life (e.g. tiling / building, restaurant, etc.): **(1)**		1	1	1	1	1
5.3 from our cultural heritage (bracelets, huts, etc.): **(1)**		0	1	0	1	0
Total Scores of all activities and aspects: (17.00)		**12.75**	**14.00**	**13.00**	**13.50**	**12.25**
C. DRAWING SKILLS: Draw, locate, trace, construct, copy, put together, tessellate						
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 4 SERIES CODING**				
1. The learner draws / copies 2-D shapes		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 circles of *2 different sizes* **(1/2** per size**)** **(1)**		0	0	0	1	0
1.2 triangles of 3 *different types according to sides, 2 different sizes & positions per type* (1/4 per size, 1/4 per position) **(3)**	**i. Equilateral**: *2 different sizes & positions* (**1/4** per size per position) **(1)**	0	0	0	3/4	0
	ii. Isosceles: *2 different sizes & positions* (**1/4** per size per position) **(1)**	0	2/4	0	1	0
	iii. Scalene: *2 different sizes & positions* (**1/4** per size per position) **(1)**	0	0	2/4	1	2/4
1.3 squares of *2 different sizes,* drawn in *2 different positions* (**1/4** per size per position) **(1)**		3/4	2/4	2/4	1	3/4
1.4 rectangles of *2 different sizes*, drawn in *2 different positions* (**1/4** per size, **1/4** per position) **(1)**		3/4	0	2/4	1	1
2. The learner draws / determines the line of symmetry		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
2.1 (-*single* and *multiples*-) in geometrical shapes (**1/2** per aspect) **(1)**		1	1	1	1	1

2.2 (-*single* and *multiples*-) in non-geometrical shapes (**1/2 per aspect**)	**(1)**	1	1	1	1	1
2.3 through paper folding and reflection on geometric and/or non-geometric shapes	**(1)**	0	0	0	0	0
3. The learner copies and extends geometric patterns made with drawings of lines, shapes or objects		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
3.1 by using **one shape / object** whose **colours / divisions change** in a regular way (circle, triangle, etc)		0	0	1	0	1
3.2 by using **one shape / object** whose **position change** in a regular way	**(1)**	0	0	0	0	0
3.3 by using **identical groups of shapes / objects repeated** together, where the size of the shape / object changes regularly by increasing / decreasing (circles & triangles or triangles & squares, etc.)	**(1)**	0	0	1	1	0
3.4 by making **identical groups of objects**, where the **groups are repeated** (same or different groups)	**(1)**	1	1	1	1	1
3.5 from a **single kind of shape**, with each example of the **shape increasing or decreasing in size**	**(1)**	1	1	1	1	1
3.6 by making ***groups, in which the same shapes / objects occur***, but the number of each kind increases or decreases regularly	**(1)**	0	1	1	1	1
4. The learner copies geometric patterns all around us		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
4.1 in nature:	**(1)**	1	1	1	0	0
4.2 from modern everyday life:	**(1)**	0	1	1	1	1
4.3 from our cultural heritage:	**(1)**	1	1	0	0	0
Total Scores of all activities and aspects: (18.00)		**7.50**	**9.00**	**10.50**	**12.75**	**9.25**

D. LOGICAL SKILLS: Sort, understand, compare, contrast

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 4 SERIES CODING**				
1. The learner sorts and compares 2-D shapes by single attributes		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 in terms of shape only (whether circle / triangle / square / rectangle)	**(1)**	1	1	1	1	1
1.2 in terms of number of straight sides (according to polygons)	**(1)**	1	1	1	1	1
1.3 in terms of round sides (non-polygons)	**(1)**	1	1	1	1	1
Total Scores of all activities and aspects: (3.00)		**3.00**	**3.00**	**3.00**	**3.00**	**3.00**

E. APPLIED SKILLS: Thinking, reasoning, **s**olving problems**,** decision making, investigation, produce or create

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 4 SERIES CODING**				
1. The learner creates own geometric patterns		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 with physical objects	**(1)**	1	1	0	1	1
1.2 by drawing lines, shapes or objects	**(1)**	1	1	1	1	1
2. The learner identifes patterns all around us		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**

2.1 in nature: flowers and leaves, etc.	**(1)**	1	0	0	0	1
2.2 from modern everyday life: plates, cups, clothes and material,	**(1)**	0	0	1	0	0
2.3 from our cultural heritage: traditional and modern bead work, etc.	**(1)**	0	0	0	0	0
Total Scores of all activities and aspects: (5.00)		**3.00**	**2.00**	**2.00**	**2.00**	**3.00**

APPENDIX C:

Evaluating the **Grade 4** Mathematics learner textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes

N.B: Appendix is comprised of relavant Grade 4 topics, concepts, skills and clarification notes in the intermediate phase Mathematics CAPS document.

SPACE AND SHAPE (Geometry):

- General content focus: Properties, relationships, orientations, positions and transformations of 2-D shapes.
- Specific content focus: The learner's experience moves from recognition and simple description to classification and more detailed description of characteristics and properties of 2-D shapes. The learner is given opportunities to draw 2-D shapes, describe transformation and symmetry.

A. VISUAL SKILLS: Recognise, Visualise depicted / drawn / written examples in the learner book as content

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		GRADE 4 SERIES CODING				
The learner recognises and visualises the following relating to 2-D shapes:		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 all 2-D shapes with straight sides (**up to hexagons,** according to number of sides, **1/4** per aspect) ..	**(1)**	1	3/4	3/4	1	3/4
1.2 the range of **different triangles** (without naming their types, **1/6** per aspect)	**(1)**	1	5/6	3/6	1	5/6
1.3 the range of **different quadrilaterals** (by group name, not their types / individual names, **1/6**)	**(1)**	1	5/6	1	1	1
1.4 the range of **2-D shapes with curved sides** (**not-polygons**, including circles, **1/4**)	**(1)**	1	1	1	1	1
1.5 the range of *regular polygons* (up to hexagons, without calling them "regular"polygons, **1/4**)	**(1)**	1	1	3/4	1	3/4
1.6 the whole range of *irregular polygons* (up to hexagons, without calling them "irregular" polygons, **1/4**)	**(1)**	1	1	1	1	1
1.7 zero symmetry, a single / double / triple / multiple line(s) of symmetry in 2-D shape(s) (**1/5** per aspect)	**(1)**	2/5	4/5	1	2/5	2/5
1.8 examples in the *environment* (non-geometrical settings) (unitary aspect)	**(1)**	1	1	1	1	1
1.9 examples in *geometric settings* (unitary aspect)	**(1)**	1	1	1	1	1
Total Scores of all activities and aspects: (Possible: 9.00)		**8.40**	**8.22**	**8.00**	**8.40**	**7.73**

B. VERBAL / WRITTEN SKILLS: Describe, name or identify (Exercises)

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		GRADE 4 SERIES CODING				
1. The learner describes 2-D shapes by their various properties:		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 in terms of straight and curved of sides	**(1)**	1	1	1	1	1
1.2 closed shapes with straight sides only as polygons	**(1)**	1	1	1	0	1
1.3 such that all closed shapes with 4 straight sides are quadrilaterals (examples thereof, **1/6**)	**(1)**	1	1	5/6	4/6	1
1.4 closed shapes with curved sides as non / not-polygons	**(1)**	1	1	1	0	1
1.5 no symmetry, a single / double / triple / multiple line(s) of symmetry in 2-D shape(s) (**1/5** per aspect)	**(1)**	1	1	3/5	1	1
2. The learner associates the correct name(s) with a given 2-D shape(s) / characteristics:		**S 1**	**S 2**	**S 3**	**S 4**	**S 5**

2.1 identifies straight and curved sides **(1)**	1	1	1	1	1
2.2 identifies and names squares and rectangles by their individual names and not the group name 'quadrilateral' **(1)**	1	1	1	1	1
2.3 identifies and names other quadrilaterals, using the group name 'quadrilateral' and not the individual names (**1/4**)**(1)**	1	3/4	2/4	2/4	3/4
3. The learner identifies and describes patterns (referring to lines, 2-D shapes, symmetry, etc)	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
3.1 identifies and names the shape(s) in the pattern (**1/2**) **(1)**	1	1	1	1	1
3.2 identifies and discusses any line symmetry of the pattern / shape (**1/2**) **(1)**	1	1	1	1	1
3.3 identifies tessellation of specific shape(s) **(1)**	1	1	1	1	1
3.4 identifies and describes pattern *in nature* at least through examples (**1/2**) **(1)**	1	1	1	1	0
3.5 identifies and describes pattern from *modern everyday life* at least through examples (**1/2**) **(1)**	1	1	1	1	1
3.6 identifies and describes pattern in *our cultural heritage* at least through examples (**1/2**) **(1)**	1	1	1	1	0
3.7 describes a geometric pattern in words (making thereof, number of additions / subtractions, stages) **(1)**	1	1	1	1	1
3.8 describes the observed relationships or rules in learner's own words in investigated and extended patterns **(1)**	1	1	1	1	1
Total Scores of all activities and aspects: (16.00)	**16.00**	**15.75**	**14.93**	**13.17**	**13.75**

C. DRAWING SKILLS: Draw, locate, trace, copy, construct, build, pack, tessellate **(Exercises)**

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 4 SERIES CODING**				
1. The learner uses given properties to	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 draw / copy 2-D shape(s) without / with one / multiple line(s) of symmetry (**on a grid**) (**1/4 aspect**) **(1)**	2/4	3/4	1	2/4	3/4
1.2 draw *irregular 2-D shapes* on grid paper (angles limited to right, smaller than and greater than right angle) **(1)**	1	1	1	1	1
1.3 draw 2-D shape(s) wherein the line of symmetry is not necessarily vertical **(1)**	1	1	1	1	1
2. The learner works with visual geometric patterns / composite diagram or shapes	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
2.1 copies patterns and / or complete (extend) *simple repeating patterns* **(1)**	0	1	1	1	1
2.2 completes pattern in which the *shape keeps its form while it grows / decreases in each stage* **(1)**	1	1	1	1	1
2.3 completes pattern in which a *shape / part of a shape is added at each stage* **(1)**	1	1	1	1	1
2.4 copies and extends pattern *with neither constant difference or ratio* **(1)**	1	1	1	1	1
3. The learner uses 2-D shapes to create tessellation / tiling patterns by	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
3.1 packing out the 2-D shapes (tiles) to make tessellated patterns without / with line(s) symmetry (**1/2** aspect) **(1)**	1	1	1	1/2	1
4. The learner uses transformations to build composite shapes	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
4.1 puts 2-D shapes together to make different composite 2-D shapes without / with line symmetry (**1/2**) (tangrams) **(1)**	1	1/2	1/2	1	1
Total Scores of all activities and aspects: (9.00)	**7.50**	**8.25**	**8.50**	**8.00**	**8.75**

D. LOGICAL SKILLS: Sort, understand, compare, contrast **(Exercises/Activities)**						
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 4 SERIES CODING**					
The learner sorts, compares and contrasts 2-D shapes by single attributes	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 in terms of straight sides (polygons) and curved, open, crossing sides (not-polygons) **(1)**	1	1	1	1	1
1.2 curved sides in terms of circle and not-circle sides **(1)**	1	1	1	0	1
1.3 in terms of the number of straight sides (triangles, quadrilaterals, pentagons, hexagons) **(1)**	1	1	1	1	1
1.4 polygons in terms of the length(s) of sides (regular **/** irregular triangles, quadrilaterals, pentagons, hexagons (1/2) **(1)**	1	1	0	0	1/2
1.5 polygons in terms of the size(s) of angles (regular **/** irregular triangles, quadrilaterals, pentagons, hexagons (1/2) **(1)**	1	1	0	0	1/2
Total Scores of all activities and aspects: (5.00)	**5.00**	**5.00**	**3.00**	**2.00**	**4.00**
E. APPLIED SKILLS: Thinking, reasoning, solve problems,decision making, investigation, produce/create.					
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 4 SERIES CODING**					
1. The learner investigates and extends geometric patterns:	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
1.1 by looking for relationships or rule patterns represented in physical or diagram form **(1)**	1	1	1	1	1
1.2 by using the relationships or rule patterns identified in physical or diagram form **(1)**	1	1	1	1	1
Total Scores of all activities and aspects: (2.00)	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**

APPENDIX D:

Evaluating the **Grade 5** Mathematics learner textbooks on their contribution toward the development of the conceptual understanding of 2-D shapes

N.B: Appendix is comprised of relavant Grade 5 topics, concepts, skills and clarification notes in the intermediate phase Mathematics CAPS document.

SPACE AND SHAPE (Geometry):

- General content focus: Properties, relationships, orientations, positions and transformations of 2-D shapes.
- Specific content focus: The learner's experience moves from recognition and simple description to classification and more detailed description of characteristics and properties of 2-D shapes. The learner is given opportunities to draw 2-D shapes, describe transformation and symmetry.

A. VISUAL SKILLS: recognise, visualise, identify by sight or eyes / visually

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 5 SERIES CODING**				
1. The learner recognises 2-D shapes, their angles and symmetry as follows:	S1	S2	S3	S4	S5
1.1 2-D shapes with *straight sides* (*polygons up to hep / septagons,* according to number of sides) (**1/5**) **(1)**	1	1	1	1	1
1.2 the range of *different triangles* (without naming their types) (**1/6**) **(1)**	1	1	1	1	1
1.3 the range of *different quadrilaterals* (without naming their types) (**1/6**) **(1)**	1	1	1	1	5/6
1.4 squares and rectangles, individually and as quadrilaterals (**1/2**) **(1)**	1	1	1	1	1
1.5 the range of 2-D *shapes with curved sides* (non-polygons, including circles) (**1/4**) **(1)**	1	1	1	1	1
1.6 the range of *regular polygons (up to hep / septagons* (word regular optional) (**1/5**) **(1)**	1	1	1	1	3/5
1.7 the range of *irregular polygons* (*up to hep / septagons*) (word irregular optional) (**1/5**) **(1)**	4/5	1	1	1	1
1.8 the right angles, angles smaller than right angles and angles greater than right angles in 2-D shapes (**1/3**)**(1)**	1	1	1	1	1
1.9 zero / single / double / triple / multiple lines of symmetry in 2-D shape(s) (**1/5**) **(1)**	1	4/5	1	1	1
1.10 2-D shapes where the line of symmetry is not only vertical, but also horizontal and/or oblique / slanting)(**1/2**) **(1)**	1	1	1	1	1
1.11 *similarities between squares and rectangles* (according to the sizes of angles and number of sides) (**1/2**)**(1)**	1	1	1	1	1
1.12 *differences between squares and rectangles* (according to the lengths of sides) (**1/2**) **(1)**	1	1	1	1	1
2. The leaner recognises (visualises) different 2-D shapes	S1	S2	S3	S4	S5
2.1 in environment (in non-geometric settings) **(1)**	1	1	1	1	1
2.2 in geometric settings **(1)**	1	1	1	1	1
Total Scores of all activities and aspects:(14.00)	**13.80**	**13.80**	**14.00**	**14.00**	**13.43**

B. VERBAL / WRITTEN SKILLS: Describe, name, identify verbally or in writing

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 5 SERIES CODING**

1. The learner associates the correct name (s) with a given / own 2-D shapes -	S1	S2	S3	S4	S5
1.1 identifies regular polygons (triangles, quadrilaterals, pentagons, hexagons and heptagons)(**1/5**) **(1)**	4/5	4/5	4/5	1	4/5
1.2 identifies irregular polygons (triangles, quadrilaterals, pentagons, hexagons and heptagons) (**1/5**) **(1)**	4/5	2/5	1	1	1
1.3 identifies circles **(1)**	1	1	1	1	0
1.4 identifies and names other 4 quadrilaterals by the group name 'quadrilateral' and not the individual names (**1/4**) **(1)**	2/4	2/4	1/4	0	3/4
1.5 identifies and names similarities between squares and rectangles (**1/2**) **(1)**	1	1	1	1	1
1.6 identifies and names differences between squares and rectangles (**1/2**) **(1)**	1	1	1	1	1
2. The learner describes (identifies) shapes, angles and line(s) of symmetry in shapes:	S1	S2	S3	S4	S5
2.1 closed shapes with straight sides as polygons (terminology optional) (**1/5**) **(1)**	1	1	1	1	1
2.2 Zero / single and multiple line(s) of symmetry in 2-D shapes (**1/3**) **(1)**	1	2/3	2/3	1	1
2.3 shapes where the line of symmetry is vertical, horizontal and diagonal / slanting / oblique(1/3) **(1)**	1	1	1	1	1
2.4 the right angles in shapes **(1)**	1	1	1	1	1
2.5 the angles smaller than the right angle in shapes **(1)**	1	0	1	1	1
2.6 the angles greater than the right angle in shapes **(1)**	1	0	1	1	1
3. The learner describes 2-D shape(s) by their characteristics:	S1	S2	S3	S4	S5
3.1 in terms of straight and curve of sides (polygons or non-polygons) **(1)**	1	1	1	1	1
3.2 in terms of the number of straight sides (from triangles up to septa / heptagons) (**1/5**) **(1)**	1	1	1	1	1
3.3 in terms of the length of sides (regular or irregular polygons) **(1)**	1	1	1	1	1
3.4 in terms of the angles in shapes (right angles, angles smaller than and angles greater than right angles)(**1/3**)**(1)**	1	1	1	1	1/3
3.5 describe closed shapes with 4 straight sides as quadrilaterals (showing all 6 examples thereof) (**1/6**) **(1)**	1	1	1	1	5/6
4. The learner describes patterns by referring to lines, 2-D shapes, line(s) of symmetry, transformations:	S1	S2	S3	S4	S5
4.1 in nature (example & name, shape(s), describe patterns verbally in terms of how to get from one stage to the next)(**1/2**) **(1)**	1	1	1	1	0
4.2 from modern everyday life (identify & describe the patterns in terms of how to get from one stage to the next) (**1/2**)**(1)**	1	1	1	1	1
4.3 from our cultural heritage (any symmetry, type of transformations, name component shape(s)involved)(**1/2**)**(1)**	1	1	0	1	0
Total Scores of all activities and aspects:(20.00)	**19.10**	**16.37**	**17.72**	**19.00**	**15.72**

C. DRAWING SKILLS: Draw, locate, trace, construct, copy,

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 5 SERIES CODING**				
1. The learner uses given (verbal / written) properties of 2-D shapes to:	S1	S2	S3	S4	S5

1.1 draw 2-D shape(s) with zero / single / multiple lines of symmetry on a grid (**1/3**) **(1)**	2/3	2/3	2/3	2/3	2/3
1.2 draw shape(s) where the line of symmetry is horizontal, vertical and diagonal (**1/3**) **(1)**	1	1	1	1	1
1.3 draw 2-D shapes on grid paper (angles limited to right, smaller than and greater than right angles) (**1/3**) **(1)**	1	1	1	1	1
2. The learner works with visual geometric patterns or composite shapes:	S1	S2	S3	S4	S5
2.1 copies / makes patterns from and / or complete simple repeating patterns **(1)**	0	1	1	1	0
2.2 completes pattern in which the shape keeps its form while it grows / decreases in each stage **(1)**	1	1	1	1	1
2.3 completes pattern in which a shape / part of a shape is added at each stage (matches / flower) (const d) **(1)**	1	1	1	1	1
2.4 copies and extends the pattern with neither constant difference nor ratio (square / triangle of 2-D shapes) **(1)**	1	1	1	1	1
3. The learner uses transformations to make tessellated patterns with and without line symmetry by	S1	S2	S3	S4	S5
3.1 tracing and moving a 2-D shape by rotation and / or translation and/or reflection (**1/3**) **(1)**	1	1	1	1	1
3.2 making / drawing tessellated patterns with and without line symmetry (**1/2**) **(1)**	1	1	1	1	0
4. The learner uses transformations to make composite 2-D shapes with and without line of symmetry by	S1	S2	S3	S4	S5
4.1 tracing and moving a 2-D shape by rotation and / or translation and/or reflection (**1/3**) **(1)**	1	1	1	1	1
4.2 making / drawing composite 2-D shapes with and without line of symmetry (**1/2**) **(1)**	1	1	1/2	1/2	0
Total Scores of all activities and aspects:(11.00)	9.67	10.67	10.17	10.17	7.67

D. LOGICAL SKILLS: Sort, understand, compare, contrast					
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 5 SERIES CODING**				
1. The learner sorts and compares 2-D shapes by single attributes :	S1	S2	S3	S4	S5
1.1 in terms of straight sides (polygons) and curved, open, crossing sides (non-polygons) **(1/2)** **(1)**	1	1	1	1	1
1.2 curved sides in terms of circle and not-circle **(1/2)** **(1)**	1	1	1	1	1
1.3 in terms of the number of straight sides (triangles, quadrilaterals, pentagons, hexagons, hep / septagons)(**1/5**) **(1)**	1	1	1	1	1
1.4 polygons in terms of the length(s) of sides (regular & irregular triangles, quadrilaterals, pentagons, hexagons and hep / septagons)(**1/10**) **(1)**	9/10	1	1	1	8/10
1.5 polygons in terms of the size(s) of angles (regular & irregular triangles, quadrilaterals, pentagons, hexagons and hep / septagons) (**1/10**) **(1)**	1	1	1	1	6/10
Total Scores of all activities and aspects: (5.00)	**4.90**	**5.00**	**5.00**	**5.00**	**4.40**

E. APPLIED SKILLS: Thinking, reasoning, Solve problems, decision making, investigating produce/create.					
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 5 SERIES CODING**				
1. The learner investigates and extends geometric patterns	S1	S2	S3	S4	S5
1.1 by looking for relationships or rule patterns represented in physical or diagram form **(1)**	1	1	1	1	1

1.2 by using the relationships or rule patterns identified in physical or diagram form **(1)**	1	1	1	1	1
Total Scores of all activities and aspects: (2.00)	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**

APPENDIX E:

Evaluating the **Grade 6** Mathematics learner textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes

N.B: Appendix is comprised of relavant Grade 6 topics, concepts, skills and clarification notes in the intermediate phase Mathematics CAPS document.

SPACE AND SHAPE (Geometry):

- General content focus: Properties, relationships, orientations, positions and transformations of 2-D shapes.
- Specific content focus: The learner's experience moves from recognition and simple description to classification and more detailed description of characteristics and properties of 2-D shapes. The learner is given opportunities to draw 2-D shapes, describe transformation and symmetry.

A. VISUAL SKILLS: recognise, visualise, identify

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 6 SERIES CODING**				
1. The learner recognises 2-D shapes, their angles and symmetry as follows		S1	S2	S3	S4	S5
1.1 2-D shapes with *straight sides* (*polygons up to the Octagon,* according to number of sides) (1/6)	**(1)**	1	1*	1	1	1
1.2 the range of non-polygons, including the circle (1/4)	**(1)**	1/2	1	1	1	1
1.3 the range of different triangles (without naming their types) (1/6)	**(1)**	1	1	1	1	1
1.4 the range of different quadrilaterals (without naming their types) (1/6)	**(1)**	5/6	5/6	1	1	1
1.5 squares, rectangles and parallelogram individually and as quadrilaterals (1/3)	**(1)**	1	1	1	1	1
1.6 similarities between rectangles and parallelograms (according to angles, sides, etc.) (1/2)	**(1)**	1	1	1	1	1
1.7 differences between rectangles and parallelograms (according to angles, sides, etc.) (1/2)	**(1)**	1	1	1	1	1
1.8 the acute, right, obtuse, straight, reflex and revolution angles in 2-D shapes (1/6)	**(1)**	1	1	1	1	1
1.9 the range of regular polygons (up to Octagons, word 'regular' optional) (1/6)	**(1)**	1	1	1	1	1
1.10 the range of irregular polygons (up to Octagons, word 'irregular' optional) (1/6)	**(1)**	1	1	1*	1	5/6
1.11 zero / single / double / triple / multiple line(s) of symmetry in 2-D shape(s)(1/5)	**(1)**	1	1	1	1*	1
1.12 2-D shapes where the line of symmetry is not only vertical or horizontal, but also diagonal (1/2)	**(1)**	1	1	1	1	1
2. The leaner recognises (visualises) different 2-D shapes		S1	S2	S3	S4	S5
2.1 in the environment (in non-geometric settings)	**(1)**	1	1	1	1	1
2.2 in geometric settings	**(1)**	1	1	1	1	1
Total Scores of all activities and aspects: (14.00)		**13.33**	**13.83**	**14.00**	**14.00**	**13.83**

B. VERBAL / WRITTEN SKILLS: Describe; discuss; identify by name; or interpret;

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 6 SERIES CODING**				
1. The learner associates the correct name(s) with given 2-D shape(s)		S1	S2	S3	S4	S5
1.1 acute, right, obtuse, straight, reflex and revolution angles separately or in 2-D shapes (**1/6**)	**(1)**	1	4/6	1	1	3/6

1.2 identifies regular polygons (triangles up to Octagons) (**1/6**) **(1)**		5/6	1	1	1	1
1.3 identifies irregular polygons (triangles up to Octagons) (**1/6**) **(1)**		4/6	1	1	1	5/6
1.4 identifies non-polygons (circles and not-circles) (**1/4**) **(1)**		1/4	1*	1	1	1
1.5 names square, rectangle, parallelogram and identifies the other quadrilaterals by the group name (**1/3**) **(1)**		1	1	1/3	1	1
1.6 identifies and names the similarities between rectangles and parallelograms (**1/2**) **(1)**		1	1	1	1	1
1.7 identifies and names the differences between rectangles and parallelograms (**1/2**) **(1)**		1	1	1	1	1
2. The learner describes (identifies)		S1	S2	S3	S4	S5
2.1 zero / single and multiple line(s) of symmetry in 2-D shapes (**1/3**) **(1)**		1	1	1	1	1
2.2 shapes where the line of symmetry is vertical, horizontal and diagonal (**1/3**) **(1)**		1	1	1	1	1
2.3 acute, right, obtuse, straight, reflex and revolution angles in 2-D shapes (**1/6**) **(1)**		1	1*	1	1	3/6
3. The learner describes 2-D shape(s) by their characteristics:		S1	S2	S3	S4	S5
3.1 in terms of the number of straight sides (triangle, quadrilateral, pentagon up to Octagon) (**1/6**) **(1)**		1	1	1	1	1
3.2 in terms of the length of sides (regular or irregular polygons) (**1/6**) **(1)**		1*	3/6	1	1	1*
3.3 in terms of sizes of angles (acute, right, obtuse, straight, reflex and revolution) (**1/6**) **(1)**		4/6	4/6	3/6	3/6	3/6
3.4 polygons with 4 straight sides as quadrilaterals (showing all 6 examples) (**1/6**) **(1)**		5/6	1	4/6	1	1
4. The learner describes patterns, referring to lines, 2-D shapes, line / s of symmetry, transformations:		S1	S2	S3	S4	S5
4.1 in nature (discusses examples, name(s), shape(s), describe patterns verbally in terms of how to get from one stage to the next) (**1/2**) **(1)**		1	0	0	0	0
4.2 from modern everyday life (identify and describe the patterns in terms of how to get from one stage to the next)(**1/2**) **(1)**		1	0	0	1	0
4.3 from our cultural heritage (identifies symmetry, transformations & name(s) of component shape(s) involved)(**1/2**)**(1)**		1	0	0	1	0
Total Scores of all activities and aspects: (17.00)		**15.25**	**12.83**	**12.50**	**15.50**	**12.33**

C. DRAWING SKILLS: Draw, locate, trace, construct, copy						
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS	**GRADE 6 SERIES CODING**					
1. The learner uses verbal or written properties of 2-D shapes to translate into a drawing	S1	S2	S3	S4	S5
1.1 different 2-D shapes on grid paper, including regular and irregular shapes (**1/2**) **(1)**	1	1	1	1	1
1.2 circles, patterns in circles, patterns with circles using a pair of compasses (**1/3**) **(1)**	1	1	1	1	1
1.3 line(s) symmetry in 2-D shape(s) (horizontal, vertical and diagonal) (**1/3**) **(1)**	1	1	1	1	1
1.4 enlargements of triangles and quadrilaterals (2-D shapes) to compare size and shape (**1/2**) **(1)**	1	1	1	1	1
1.5 reductions of 2-D shapes (triangles and quadrilaterals) (**1/2**) **(1)**	1	1	1	1	1
2. The learner works with visual geometric patterns / investigate and extends patterns by:	S1	S2	S3	S4	S5

2.1 copying, completing and/or extending simple repeating patterns (**1/2**)	**(1)**	0	1	1	1	0
2.2 completing pattern(s) in which the shape keeps its form while it grows/ decreases at each stage (**1/2**)	**(1)**	1	1	1	1	1
2.3 completing pattern(s) in which a shape / pattern of / part of a shape is added at each stage (**1/2**)	**(1)**	1	1	1	1	1
2.4 completing patterns with neither constant difference or ratio (**1/2**)	**(1)**	1	1	1	1	1
Total Scores of all activities and aspects:(9.00)		**8.00**	**9.00**	**9.00**	**9.00**	**8.00**

D. LOGICAL SKILLS: Sort, understand, compare, contrast

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 6 SERIES CODING**				
1. The learner sorts and compares 2-D shapes by single attributes		S1	S2	S3	S4	S5
1.1 polygons in terms of the number of straight sides (triangles, quadrilaterals up to Octagons) (**1/6**)	**(1)**	1	1	1	1	1
1.2 non-polygons in terms of circle and not circle (**1/2**)	**(1)**	1/2	1	1	1	1
1.3 polygons in terms of the length(s) of sides (regular & irregular triangles, quadrilaterals up to Octagons)(**1/12**)	**(1)**	7/12	1	0	1	2/12
1.4 polygons in term of the sizes of angles (regular & irregular triangles, quadrilaterals up to Octagons) (**1/12**)	**(1)**	7/12	1	0	0	0
1.5 size(s) and shape(s) of triangles and quadrilaterals transformed through enlargement and/or reduction	**(1)**	1	1	0	1	1
Total Scores of all activities and aspects: (5.00)		**3.67**	**5.00**	**2.00**	**4.00**	**3.17**

E. APPLIED SKILLS: Thinking, reasoning, solving problems, decision making, investigation, produce or create

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 6 SERIES CODING**				
1. The learner investigates and extends geometric patterns:		S1	S2	S3	S4	S5
1.1 looks for relationships or rule patterns represented in physical or diagram form	**(1)**	1	1	1	1	1
1.2 extends geometric patterns using the relationships or rule patterns identified in physical or diagram form	**(1)**	1	1	1	1	1
Total Scores of all activities and aspects: (2.00)		**2.00**	**2.00**	**2.00**	**2.00**	**2.00**

APPENDIX F: Progression from grade 6 to grade 7

Evaluating the Grade 6 Mathematics learner textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes

N.B: Appendix is comprised of relavant Grade 7 topics, concepts, skills and clarification notes in the senior phase Mathematics CAPS document.

SPACE AND SHAPE (Geometry):

- **General content focus:** Properties, relationships, orientations, positions, and transformations of 2-D shapes
- **Specific content focus:** Drawing and constructing a widerange of geometric figures,developing an appreciation for the use of construction to investigate the properties of geometric figure, developing a clear and more precise descriptions and classification categories of geometric figures, solving a variety of geometric problems.

A. VISUAL SKILLS: recognise, visualise, identify

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		GRADE 6 SERIES CODING				
1. The learner recognises the following properties of 2-D shape (s)		S1	S2	S3	S4	S5
1.1 lines of symmetry in geometric shape(s) (horizontal, vertical and diagonal) (**1/3**)	**(1)**	1	1	1	1	1
1.2 *similar figures* by comparing their shapes and sizes (**1/2**)	**(1)**	0	0	0	0	0
1.3 *congruent figures* by comparing their shapes and sizes (**1/2**)	**(1)**	0	0	0	0	0
1.4 transformations (rotations, reflections and translations) of geometric shape(s) (**1/3**)	**(1)**	1	1	1	1	1
Total Scores of all activities and aspects:(4.00)		**2.00**	**2.00**	**2.00**	**2.00**	**2.00**

B. VERBAL / WRITTEN SKILLS: Describe; discuss; identify by name or interpret

TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		GRADE 6 SERIES CODING				
1. The learner associates the correct name(s) with given 2-D shape(s) / properties:		S1	S2	S3	S4	S5
1.1 the different parts of a circle (arc, chord, circumference, diameter, radius, sector, segment) (**1/7**)	**(1)**	1/7	0	3/7	3/7	1/7
1.2 triangles according to sides, focussing on *equilate*ral, isosceles and scalene triangles (**1/3**)	**(1)**	0	0	0	0	1
1.3 triangles according to angles, focussing on acute-, obtuse- and right-angled triangles (**1/3**)	**(1)**	0	0	0	0	2/3
1.4 quadrilaterals in term of length of sides: *all sides equal* (square and rhombus) (**1/2**)	**(1)**	1/2	1	0	0	1/2
1.5 quads with *opposite sides equal* (rectangle / parallelogram / square / rhombus) (**1/4**)	**(1)**	3/4	2/4	2/4	0	1/4
1.6 quads with *at least one pair of adjacent sides equal* (square / rhombus / kite) (**1/3**)	**(1)**	0	0	0	0	2/3
1.7 quadrilaterals with *perpendicular sides* (square, rectangle) (**1/2**)	**(1)**	0	0	0	0	0
1.8 quads with *two pairs of opposite sides parallel* (rectangle, square, parallelogram) (**1/3**)	**(1)**	1/3	0	2/3	0	0
1.9 quads with *one pair of opposite sides parallel* (trapezium)	**(1)**	0	0	0	0	0
1.10 quadrilaterals with a*ll four angles right angles* (square, rectangle) (**1/2**)	**(1)**	1	1	1	0	1

2. The learner describes 2-D shape(s) by their characteristics, focusing on		S1	S2	S3	S4	S5
2.1 the parts of a circle (**1/7**)	**(1)**	1/7	0	3/7	3/7	1/7
2.2 equilateral triangles, according to their sides and angles (**1/3**)	**(1)**	1	0	0	0	1
2.3 isosceles triangles, according to their sides and angles (**1/3**)	**(1)**	0	0	1	0	1
2.4 scalene triangles, according to their sides and angles (**1/3**)	**(1)**	0	0	1	0	1
2.5 square and rhombus: as quadrilaterals with *all sides equal* (**1/2**)	**(1)**	1/2	1/2	1/2	1/2	1/2
2.6 rectangle / parallelogram / square / rhombus as quadrilaterals with *opposite sides equal* (**1/4**)	**(1)**	3/4	3/4	2/4	2/4	0
2.7 square/ rhombus / kite as quadrilateral with *at least one pair of adjacent sides equal* (**1/2**)	**(1)**	0	0	0	0	0
2.8 square, rectangle as quadrilaterals with perpendicular sides (**1/2**)	**(1)**	1	0	0	0	0
2.9 rectangle, square, parallelogram as quadrilaterals with *two pairs of opposite sides parallel*(**1/3**)	**(1)**	1	0	1/3	0	0
2.10 trapezium as a quadrilateral with one pair of opposite sides parallel (**1/2**)	**(1)**	0	0	0	0	0
2.11 square, rectangle as quadrilaterals with *all four angles as right angles* (**1/2**)	**(1)**	1	0	1	1	1/2
2.12 similar and congruent figures by comparing the shape(s) (**1/2**)	**(1)**	0	0	0	0	0
2.13 similar and congruent figures by the comparing size(s) (**1/2**)	**(1)**	0	0	0	0	0
3. The learner describes transformation geometry		S1	S2	S3	S4	S5
3.1 translations, reflections and rotations of geometric figures and shapes on *squared paper* (**1/4**)	**(1)**	1	1	1	3/4	0
Total Scores of all activities and aspects: (24.00)		**9.12**	**4.75**	**8.36**	**3.61**	**8.37**

C. DRAWING SKILLS: Draw, locate, trace, copy, construct, perform,						
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 6 SERIES CODING**				
1. The learner uses transformations, enlargement and reductions to:		S1	S2	S3	S4	S5
1.1 draw line(s) of symmetry in 2-D shape(s) (horizontal, vertical and diagonal) in transformations (**1/3**)	**(1)**	0	0	1	0	0
1.2 draw *dilations / enlargements* of geometric figures on *squared paper* (**1/2**)	**(1)**	1	1	1	1	1
1.3 draw *reductions*of geometric figures on *squared paper* (**1/2**)	**(1)**	1	1	1	1	1
1.4 construct angles, circles, parallel and perpendicular lines using compass, rule and protractor (**1/4**)	**(1)**	3/4	1/4	1/4	1/4	1/4
Total Scores of all activities and aspects: (4.00)		**2.75**	**2.25**	**3.25**	**2.25**	**2.25**

D. LOGICAL SKILLS: Sort, understand, compare, contrast						
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 6 SERIES CODING**				
1. The learner sorts, compares and classifies 2-D shapes by single attributes		S1	S2	S3	S4	S5
1.1 angles in terms of acute, right, obtuse, straight, reflex (**1/5**)	**(1)**	4/5	3/5	4/5	3/5	1

1.2 equilateral, isosceles and scalene triangles according to their sides (**1/3**)	**(1)**	1	1	2/3	0	1
1.3 acute-, obtuse- and right-angled triangles according to their angles (**1/3**)	**(1)**	1/3	1	1	0	0
1.4 quadrilaterals in terms of lengths of sides (**1/6**)	**(1)**	3/6	3/6	3/6	3/6	4/6
1.5 quadrilaterals in terms of parallel sides (**1/6**)	**(1)**	3/6	0	2/6	0	4/6
1.6 quadrilaterals in terms of perpendicular sides (**1/6**)	**(1)**	0	0	0	0	0
1.7 quadrilaterals in terms of sizes of angles (right-angles or not) (**1/6**)	**(1)**	3/6	3/6	3/6	2/6	0
1.8 *enlargements / dilations* of shapes in terms of shape and size (**1/2**)	**(1)**	1	1	1	1	1
1.9 r*eductions* of shapes in terms of shape and size (**1/2**)	**(1)**	1	1	1	1	1
Total Scores of all activities and aspects: (9.00)		**5.63**	**5.60**	**5.80**	**3.43**	**5.33**
E. APPLIED SKILLS: Thinking, reasoning, solve problems, decision making, investigating, produce / create						
TEACHING-LEARNING ACTIVITIES EXPECTED TO BE PROVIDED TO LEARNERS IN THE TEXTBOOKS		**GRADE 6 SERIES CODING**				
1. The learner solves simple geometric problems involving unknown sides and angles by using known geometric properties and definitions,		S1	S2	S3	S4	S5
1.1 of equilateral triangles, giving reasons for solutions (**1/2**)	**(1)**	0	0	0	0	0
1.2 of isosceles triangles, giving reasons for solutions (**1/2**)	**(1)**	0	0	0	0	0
1.3 of quadrilaterals, giving reasons for solutions (**1/2**)	**(1)**	0	0	0	0	0
2.The learner accurately constructs 2-D geometric shape(s) with aid of a compass, ruler & protractor		S1	S2	S3	S4	S5
2.1 accurately *using a protractor to measure angles (acute, obtuse, up to reflex)* (**1/6**)	**(1)**	0	0	0	0	0
Total Scores of all activities and aspects:4.00		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

APPENDIX G:

Evaluating Grade 4 Mathematics learner textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes

NB: Appendix represents the expected or inferred results of the evaluation to determine the achievement of level 0 at Grade 4 according to Van Hiele level descriptors and sample learner responses.

Van Hiele Level Descriptors and Sample Student Responses **Level 0:** Student identifies and operates on 2-D shapes and other geometric configurations according to their appearance						
A.VISUAL SKILLS: Recognise, visualise depicted, drawn or written examples, identify by sight						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 4 SERIES CODING**				
1. The learner identifies instances of each 2-D shape by its appearance as a whole		S 1	S 2	S 3	S 4	S 5
1.1 identifies *circles, triangles*, *squares*, *rectangles* in a simple drawing / diagram / set of cut-outs shapes (1/4) **(1)**		1	1	1	1	1
1.2 **points-out** the 2-D **shapes** and **geometric configurations** in **2 different positions** on a page of diagrams, drawings or in a photograph **(4)**	**i.** Acute, Right or Obtuse **Angle**(1/2**)** **(1)**	1	0	0	0	0
	ii. Equilateral, Isosceles or Scalene **Triangle** (1/6) **(1)**	1	5/6	3/6	5/6	1
	iii. Squares (1/2) **(1)**	1	1	1	1	1
	iv. Rectangles (1/2) **(1)**	1	1	1	1	1
	v. Lines (parallel, perpendicular lines or lines of symmetry) (1/6) **(1)**	2/6	2/6	2/6	2/6	2/6
1.3 points to the *acute / right / obtuse angle(s) in a 2-D shape*: square, rectangle or trapezoid, etc. (1/2) **(1)**		0	0	0	0	0
2. The learner identifies a shape(s) as part of a larger shape:		S 1	S 2	S 3	S 4	S 5
2.1 Recognises shapes embedded in others (e.g. triangles in a square with its diagonals drawn) (**1)**		1	0	1	1	1
2.2 fits jig-saw pieces together, thereby revealing the bigger figure (1/4) **(1)**		0	0	0	0	1
Total Scores on all activities and aspects: (9.00)		**6.33**	**4.17**	**4.83**	**5.17**	**6.33**
B. VERBAL / WRITTEN SKILLS: Describe; discuss; identify by name or interpret						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 4 SERIES CODING**				
1. The learner names 2-D shapes and uses standard/non-standard names appropriately:		S 1	S 2	S 3	S 4	S 5
1.1 points / refers to angles of a triangle / square / rectangle, *calling them "corners"* (acute / right / obtuse)(1/3) **(1)**		1	0	0	0	0
1.2 *refers to angles by colour* (e.g. red angle) *or letter symbols* (e.g. angles A & B add to make C) **(1)**		0	0	0	0	0
1.3 identifies a 2-D shape from visual / written clues if the figure is or the clues are gradually revealed at each stage, by giving its possible names (1/4) **(1)**		0	0	0	0	0
2. The learner verbally describes the 2-D shapes by their appearance as a whole:		S 1	S 2	S 3	S 4	S 5
2.1 a rectangle as "looking like a square" (1/2) **(1)**		0	0	0	0	0

2.2 a parallelogram as “a slanty rectangle” (1/2)	**(1)**	0	0	0	0	0
2.3 an angle as “like hands of a clock” (1/2)	**(1)**	0	0	0	0	0
Total Scores on all activities and aspects: (6.00)		**1.00**	**0.00**	**0.00**	**0.00**	**0.00**
C. DRAWING SKILLS: Draw, locate, trace, construct, copy						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 4 SERIES CODING**				
1. The learner constructs, draws or copies 2-D shape(s) and / or geometric configurations		S 1	S 2	S 3	S 4	S 5
1.1 makes the 2-D shapes (triangles, squares, rectangles) with D or match stix (1/3)	**(1)**	1	1/3	1	1	1
1.2 makes geometric configurations / figures: parallel, perpendicular or symmetry lines with D-stix / outlines (1/3)	**(1)**	1/3	1/3	1/3	1/3	1/3
1.3 outlines / traces angle(s), 2-D shape(s), line(s), ladder(s) in a grid (1/5)	**(1)**	2/5	2/5	2/5	2/5	2/5
1.4 makes a tiling pattern with cut-out triangles, squares or rectangles	**(1)**	1	1	1	1	1
1.5 copies self-made or ready-made pattern(s) piece by piece on paper	**(1)**	0	1	1	1	1
Total Scores on all activities and aspects: (5.00)		**2.73**	**3.07**	**3.73**	**3.73**	**3.73**
D. LOGICAL SKILLS: Sort, compare, contrast						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 4 SERIES CODING**				
1. The learner compares and sorts shapes on the basis of their appearance as a whole :		S 1	S 2	S 3	S 4	S 5
1.1 differentiates a square and rectangle by name (1/2)	**(1)**	1	1	1	1	1
1.2 differentiates a square and rectangle through drawings / cut-outs of either one being “wider or longer”	**(1)**	0	0	0	0	0
1.3 by sorting cut-out shapes of quadrilaterals into squares, rectangles, etc., because “they look alike”	**(1)**	0	0	0	0	0
Total Scores on all activities and aspects: (3.00)		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
E. APPLIED SKILLS: Thinking, reasoning, solve problems, decision making, investigation, produce or create						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES IN THE TEXTBOOK		**GRADE 4 SERIES CODING**				
1. The learner solves routine problems by operating on shapes rather than by using general properties		S 1	S 2	S 3	S 4	S 5
1.1 solves tangram puzzles by making square, parallelogram, etc. from two small triangle or other pieces	**(1)**	1	1	1	1	1
1.2 verifies that opposite sites of a rectangle are parallel by placing D-stix on edges/by other means (1/2)	**(1)**	0	0	0	0	0
1.3 uses transparent “angle overlay” to find the measure of the third angle of a triangle (1/2)	**(1)**	0	0	0	0	0
2. The learner identifies parts of a figure but, does NOT		S 1	S 2	S 3	S 4	S 5
2.1 analyse a figure in terms of its components (e.g. identifies squares by appearance as a whole, but **does not spontaneously introduce “equal sides and right angles” or square corners**”) (1/2)	**(1)**	0	1	1/2	1	1/2

2.2 think of properties as characterising a class of figures (e.g. points to sides of a square and measures to check they are equal but **does not generalise equal sides for all squares**) (1/2) **(1)**	1	1	1	1	1
2.3 make generalisations about shapes or use related language (**does not spontaneously use "all, some, every, none" and other such quantifiers** in telling whether all, some, or none of a certain type of shape have a property) **(1)**	1	1	1	1	1
Total Scores on all activities and aspects: (6.00)	**3.00**	**4.00**	**3.50**	**4.00**	**3.50**

APPENDIX H:

Evaluating Grade 5 Mathematics learner textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes

NB: Appendix represents the expected or inferred results of the evaluation to determine the achievement of level 1 at Grade 5 according to Van Hiele level descriptors and sample learner responses.

Van Hiele Level Descriptors and Sample Student Responses **Level 1:** Student analyses figures in terms of their **components** and **relationships between components**, **establishes properties of a class of figures** empirically and uses properties to solve problems.						
A.VISUAL SKILLS: Recognise, visualise, identify by sight						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 5 SERIES CODING**				
1. The learner identifies and tests relationships among components of figures:		S 1	S 2	S 3	S 4	S 5
1.1 congruence of opposite sides of a rectangle, rhombus, parallelogram (1/3)	**(1)**	2/3	0	2/3	1/3	1/3
1.2 congruence of **opposite angles** of a kite, rhombus, parallelogram (1/3)	**(1)**	0	0	0	0	0
1.3 congruence of all angles of an equilateral triangle, square, rectangle (1/3)	**(1)**	1/3	0	2/3	1	2/3
1.4 congruence of all sides of an equilateral triangle, square, rhombus (1/3)	**(1)**	1	0	1/3	1	1/3
1.5 congruence of diagonals of quadrilaterals: square, rectangle, isosceles trapezium (1/4)	**(1)**	0	0	0	0	0
1.6 congruence of angles in a tiling pattern	**(1)**	0	0	0	0	0
Total Scores on all activities and aspects: (6.00)		**2.00**	**0.00**	**1.67**	**2.00**	**1.33**
B. VERBAL / WRITTEN SKILLS: Describe; discuss; identify by name; or interpret						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 5 SERIES CODING**				
1. The learner recalls and uses appropriate vocabulary for components and relationships		S 1	S 2	S 3	S 4	S 5
1.1 observes that opposite sides are parallel for a rectangle, parallelogram (1/2) and verifies	**(1)**	0	0	1/2	0	0
1.2 diagonals bisect each other for a square, rectangle, rhombus, parallelogram and not for a kite, trapezium (1/6)	**(1)**	0	0	0	0	0
1.3 corresponding angles and alternating angles are congruent (equal) (1/2)	**(1)**	0	0	0	0	0
1.4 co-interior angles are supplementary	**(1)**	0	0	0	0	0
2. The learner tells what shape a figure is, given certain properties		S 1	S 2	S 3	S 4	S 5
2.1 on the basis of certain properties given as clues about a shape, tells what shape it must be	**(1)**	1	0	0	1	1
3. The learner describes a class of figures in terms of its properties		S 1	S 2	S 3	S 4	S 5
3.1 describes a triangle (1/3)	**(1)**	1	1	1	1	1

3.2 describes quadrilaterals: square, rectangle, parallelogram, rhombus, trapezium, kite (1/6) **(1)**		2/6	0	2/6	4/6	2/6
4. The learner formulates and uses generalisations with related language about properties of figures		S 1	S 2	S 3	S 4	S 5
4.1 lists many properties of quadrilaterals: square, rectangle, parallelogram, rhombus, kite, trapezium, without identifying a set of sufficient properties for definition (not formulating and using formal definitions) (1/6) **(1)**		2/6	0	2/6	4/6	2/6
Total Scores on all activities and aspects: (8.00)		**2.67**	**1.00**	**2.17**	**3.33**	**2.67**
C. DRAWING SKILLS: Draw, locate, trace, construct, copy						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 5 SERIES CODING**				
1. The learner interprets and uses descriptions of a figure, in terms of its properties, to draw the figure		S 1	S 2	S 3	S 4	S 5
1.1 reads property cards (e.g. 4 sides, all sides equal) and draws a shape with the properties **(1)**		1	0	0	0	1
Total Scores on all activities and aspects: (1.00)		**1.00**	**0.00**	**0.00**	**0.00**	**1.00**
D. LOGICAL SKILLS: Sort, understand, compare, contrast						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 5 SERIES CODING**				
1. The learner compares two shapes / cut-outs according to relationships among their components:		S 1	S 2	S 3	S 4	S 5
1.1 tells how a square and rectangle are alike and different in terms of their angles, sides (1/4) **(1)**		1	1	0	1	1
1.2 notes how a square and a rhombus are alike and different in terms of angles, sides **(1)**		0	0	0	0	0
1.3 notes how a rectangle and a parallelogram are alike and different in terms of angles, sides **(1)**		0	0	0	0	0
2. The learner sorts shapes in different ways according to certain properties:		S 1	S 2	S 3	S 4	S 5
2.1 makes up a rule for sorting quadrilateral according to number of, right angles, pairs of parallel sides; pairs of opposite angles that are equal and pairs of adjacent sides the are equal (1/4) **(1)**		1/4	1/4	1/4	2/4	2/4
3. The learner discovers properties of an unfamiliar class of figures		S 1	S 2	S 3	S 4	S 5
3.1 sorts quadrilaterals into kites and non-kites to discover and verbalize properties that characterise kites **(1)**		0	0	0	0	0
Total Scores on all activities and aspects: (5.00)		**1.25**	**1.25**	**0.25**	**1.50**	**1.50**
E. APPLIED SKILLS: Thinking, reasoning, solving problems, decision making, investigating, produce, create						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 5 SERIES CODING**				
1. The learner interprets verbal or symbolic statements of rules and applies them		S 1	S 2	S 3	S 4	S 5
1.1 describes a “saw” shown in a property card and uses it to identify congruent angles in a grid **(1)**		0	0	0	0	0
1.2 describes the C, F and Z-shape angles and uses them to identify congruent angles in a grid (1/3) **(1)**		0	0	0	0	0
2. The learner discovers properties of specific figures empirically & generalises them for that class of figures		S 1	S 2	S 3	S 4	S 5

2.1 in a triangular grid, notes that “the three angles of a triangle are the same as the three angles that make a straight line and so the sum of angles of a triangle is 180°” **(1)**	0	0	0	0	0
2.2 discovers that the exterior angle of a triangle equals the sum of its two non-adjacent interior angles **(1)**	0	0	0	0	0
3. The learner solves geometric problems by using known properties of figures or by insightful approaches	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
3.1 solves for missing angles based on the sum of three angles of a triangle being 180˚ **(1)**	0	0	0	0	0
3.2 determines that the sum of angles of a quadrilateral is 360˚ **(1)**	0	0	0	0	0
3.3 without measuring, find the sum of the angles in a pentagon / hexagon / heptagon **(1)**	0	0	0	0	0
4. The learner identifies which properties used to characterise one class of figures also apply to another class of figures and compares classes of figures according to their properties	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
4.1 having noted that parallelograms have “opposites sides parallel”, spontaneously adds “so do squares, rectangles, rhombi” (1/3) **(1)**	0	0	0	0	0
Total Scores on all activities and aspects: (8.00)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

APPENDIX I:

Evaluating Grade 6 Mathematics learner textbooks on their contribution towards the development of the conceptual understanding of 2-D shapes

NB: Appendix represents the expected or inferred results of the evaluation to determine the achievement of level 1 at Grades 6 according to Van Hiele level descriptors and sample learner responses.

Van Hiele Level Descriptors and Sample Student Responses **Level 1:** Student analyses figures in terms of their **components** and **relationships between components**, **establishes properties of a class of figures** empirically and uses properties to solve problems.						
A.VISUAL SKILLS: Recognise, visualise, identify by sight						
LEVEL DESCRIPTOR AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 6 SERIES CODING**				
1. The learner identifies and tests relationships among components of figures:		S 1	S 2	S 3	S 4	S 5
1.1 congruence of opposite sides of a square, rectangle, rhombus, parallelogram (1/3)	**(1)**	3/4	1/4	2/4	3/4	1
1.2 congruence of **opposite angles** of a square, kite, rectangle, rhombus, parallelogram (1/5)	**(1)**	2/5	2/5	2/5	3/5	0
1.3 congruence of all angles of an equilateral triangle, square, rectangle (1/3)	**(1)**	1	1	2/3	1	2/3
1.4 congruence of all sides of an equilateral triangle, square, rhombus (1/3)	**(1)**	1	1	1/3	2/3	2/3
1.5 congruence of diagonals of quadrilaterals: square, rectangle, isosceles trapezium (1/4)	**(1)**	0	0	0	0	0
1.6 congruence of angles in a tiling pattern	**(1)**	0	0	0	0	0
Total Scores of all activities and aspects: (6.00)		**3.15**	**2.65**	**1.90**	**2.02**	**2.33**
B. VERBAL / WRITTEN SKILLS: Describe; discuss; identify by name; or interpret						
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK		**GRADE 6 SERIES CODING**				
1. The learner recalls and uses appropriate vocabulary for components and relationships		S 1	S 2	S 3	S 4	S 5
1.1 observes that opposite sides are parallel for a square, rectangle, parallelogram, rhombus and verifies (1/4)	**(1)**	3/4	0	2/4	0	1
1.2 diagonals bisect each other for a square, rectangle, rhombus, parallelogram and not for a kite, trapezium (1/6)	**(1)**	0	0	0	0	0
1.3 corresponding angles and alternating angles are congruent (equal) (1/2)	**(1)**	0	0	0	0	0
1.4 co-interior angles are supplementary	**(1)**	0	0	0	0	0
2. The learner tells what shape a figure is, given certain properties		S 1	S 2	S 3	S 4	S 5
2.1 on the basis of certain properties given as clues about a shape, tells what shape it must be	**(1)**	1	0	0	1	0
3. The learner describes a class of figures in terms of its properties		S 1	S 2	S 3	S 4	S 5
3.1 describes a triangle	**(1)**	1	1	1	1	1
3.2 describes quadrilaterals: square, rectangle, parallelogram, rhombus, trapezium, kite (1/6)	**(1)**	5/6	4/6	3/6	3/6	4/6

4. The learner formulates and uses generalisations with related language about properties of figures	S 1	S 2	S 3	S 4	S 5
4.1 lists many properties of quadrilaterals: square, rectangle, parallelogram, rhombus, kite, trapezium, without identifying a set of sufficient properties for definition (not formulating and using formal definitions) (1/6) **(1)**	5/6	3/6	3/6	3/6	4/6
Total Scores of all the activities and aspects: (8.00)	**4.42**	**2.17**	**2.50**	**3.00**	**3.33**
C. DRAWING SKILLS: Draw, locate, trace, construct, copy					
LEVEL DESCRIPTOR AND SAMPLE LEARNER RESPONSES IN THE TEXTBOOK	**GRADE 6 SERIES CODING**				
1. The learner interprets and uses descriptions of a figure, in terms of its properties, to draw the figure	S 1	S 2	S 3	S 4	S 5
1.1 reads property cards (e.g. 4 sides, all sides equal) and draws a shape which with the properties **(1)**	1	0	0	1	0
Total Scores of all activities and aspects: (1.00)	**1.00**	**0.00**	**0.00**	**1.00**	**0.00**
D. LOGICAL SKILLS: Sort, understand, compare, contrast					
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK	**GRADE 6 SERIES CODING**				
1. The learner compares two shapes / cut-outs according to relationships among their components:	S 1	S 2	S 3	S 4	S 5
1.1 tells how a square and rectangle are alike and different in terms of their angles and sides (1/4) **(1)**	1	0	0	1	1
1.2 notes how a square and a rhombus are alike and different in terms of angles and sides **(1)**	0	0	0	0	1
1.3 notes how a rectangle and a parallelogram are alike and different in terms of angles and sides **(1)**	1	1	1	1	1
2. The learner sorts shapes in different ways according to certain properties:	S 1	S 2	S 3	S 4	S 5
2.1 makes up a rule for sorting quadrilaterals according to number of, right angles, pairs of parallel sides; pairs of opposite angles that are equal and pairs of adjacent sides that are equal (1/4) **(1)**	2/4	2/4	0	3/4	0
3. The learner discovers properties of an unfamiliar class of figures	S 1	S 2	S 3	S 4	S 5
3.1 sorts quadrilaterals into kites and non-kites to discover and verbalise properties that characterises kites **(1)**	0	0	0	0	0
Total Scores of all activities and aspects: (5.00)	**2.50**	**1.50**	**1.00**	**2.75**	**3.00**
E. APPLIED SKILLS: Thinking, reasoning, solving problems, decision making, investigation, produce, create					
LEVEL DESCRIPTORS AND SAMPLE LEARNER RESPONSES EXPECTED IN THE TEXTBOOK	**GRADE 6 SERIES CODING**				
1. The learner interprets verbal or symbolic statements of rules and applies them	S 1	S 2	S 3	S 4	S 5
1.1 describes a “saw” shown in a property card and uses it to identify congruent angles in a grid **(1)**	0	0	0	0	0
1.2 describes the C, F and Z-shape angles and uses them to identify congruent angles in a grid (1/3) **(1)**	0	0	0	0	0
2. The learner discovers properties of specific figures empirically & generalises them for that class of figures	S 1	S 2	S 3	S 4	S 5
2.1 in a triangular grid, notes that “the three angles of a triangle are the same as the three angles that make a straight line and so the sum of angles of a triangle is 180°” **(1)**	0	0	0	0	0
2.2 discovers that the exterior angle of a triangle equals the sum of its two non-adjacent interior angles **(1)**	0	0	0	0	0

3. The learner solves geometric problems by using known properties of figures or by insightful approaches	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
3.1 solves for missing angles based on the sum of three angles of a triangle being 180˚ **(1)**	0	0	0	0	0
3.2 determines that the sum of angles of a quadrilateral is 360˚ **(1)**	0	0	0	0	0
3.3 without measuring, finds the sum of the angles in a pentagon / hexagon / heptagon **(1)**	0	0	0	0	0
4. The learner identifies which properties used to characterise one class of figures also apply to another class of figures and compares classes of figures according to their properties	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
4.1 having noted that parallelograms have “opposites sides parallel”, spontaneously adds “so do squares, rectangles, rhombi”(1/3) **(1)**	2/3	0	1/3	0	2/3
Total Scores of all activities and aspects: (8.00)	**0.67**	**0.00**	**0.33**	**0.00**	**0.67**

APPENDIX J:

Readability Test Results: Print-outs of results for Grade 4, series 1 – 5; Grade 5, series 1 – 5 and Grade 6, series 1 – 5 of the learner's textbooks.

Grade 4: Series 1 - 5

Grammer & Plagiarism Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 9 Learners Book
P590 Exercise 17-3 # 2a-e

SERIES 824 Tweet 274

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	370.00 ✓ Typo?
Number of words :	94.00
Number of sentences :	15.00
Average number of characters per word :	3.94
Average number of syllables per word :	1.31
Average number of words per sentence:	6.27

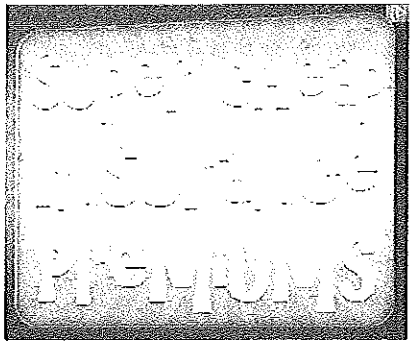
Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog Index :	2.51 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau Index :	2.60
Flesch Kincaid Grade level :	2.29
ARI (Automated Readability Index) :	0.24
SMOG :	3.00

Flesch Reading Ease : 89.77 Easy, Grade 5, 11 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Write down the rule that gives the output (number of dots) for the input (diagram number).
- Draw up a table and write the rule above the table, with inputs 1 to 5.
- How many dots will be needed for diagram number 8?
- Copy this pattern into your wookbook.



✓ ✓ 94; 103; 74 ✓ 167; 92; 47 ✓ 62; 78; 92; 98; 116 ✓

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

GRADE 4: LEARNER'S BOOK
PG197 Exercise 40.4

SERIES 820 Tweet 272

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

1.

Topic??

Number of characters (without spaces) :	475.00
Number of words :	103.00 ✓
Number of sentences :	12.00
Average number of characters per word :	4.61
Average number of syllables per word :	1.45
Average number of words per sentence:	8.58

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index : ✓	6.15 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index : ✓	7.87
Flesch Kincaid Grade level : ✓	4.83
ARI (Automated Readability Index) :	4.58
SMOG : ✓	7.74

Flesch Reading Ease : ✓ 75.74 Fairly Easy, Grade 6, 12yrs

7/8 ideal score.

Fog :
5 – readable
10 – hard
15 – difficult
20 – very difficult

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Find at least three objects in nature (or pictures of objects) that show different patterns.
- Draw something in nature that you think has beautiful patterns.
- Write down at least four descriptive word (adjectives) for each object.

* Text Readability Consensus Calculator (7 popular readability formulas)
(http://www.readabilityformulas.com/free-readability-calculators.php)
→ 1 The Flesch Reading Ease Formula ✓
→ 2 The Flesch-Kincaid Grade level ✓
→ 3 The Fog Scale ✓
→ 4 The Smog index ✓
→ 5 The Coleman-Liau Index ✓
→ 6 The Automated Readability Index ✓
→ 7. Linsear Write Formula

Grammer & Plagiarism Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 4 : Learners Book
PS 90 Exercise 3 #9, 2, 3, 4

SERIES

824 Tweet 274

2

This free online software tool calculates readability : Coleman Liau Index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	280.00
Number of words :	67.00
Number of sentences :	9.00
Average number of characters per word :	4.18
Average number of syllables per word :	1.36
Average number of words per sentence:	7.44

Typic

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	3.57 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	4.79
Flesch Kincaid Grade level :	3.34
ARI (Automated Readability Index) :	1.98
SMOG :	5.58

Flesch Reading Ease : 84.37 Easy, Grade 5, 11 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Identify the missing rule for each of the flow diagrams and fill in the missing numbers.
- Look at each of the patterns and write how many items are used in each pattern.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other** Grade 4 : Learner's Book

PJ 148 Exercise 6 #1,2,3

Topic??

Tests Document Readability

SERIES 2.

This free online software tool calculates readability : Coleman Liau Index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	371.00
Number of words :	92.00
Number of sentences :	15.00
Average number of characters per word :	4.03
Average number of syllables per word :	1.32
Average number of words per sentence:	6.13

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	3.76 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	3.06
Flesch Kincaid Grade level :	2.32
ARI (Automated Readability Index) :	0.63
SMOG :	5.45

Flesch Reading Ease : 89.34 Easy, Grade 5, 11 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- In your book trace around the shapes you have made.
- You will need a piece of squared paper for this task.
- Cut another piece off the remainder of the square.
- Cut a piece off the left corner of your square.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 4 – Learners Book
P3 – Activity 4 Quadrilaterals

Series 3

824 Tweet 274

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	269.00
Number of words :	47.00
Number of sentences :	5.00
Average number of characters per word :	5.72
Average number of syllables per word :	2.00
Average number of words per sentence:	9.40

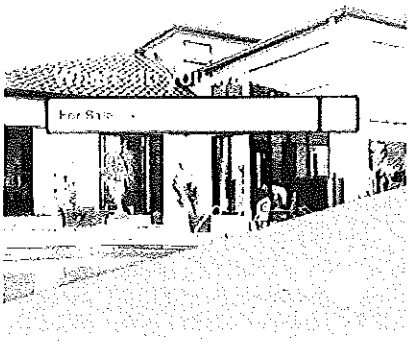
Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog Index :	10.57 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau Index :	14.72
Flesch Kincaid Grade level :	11.68
ARI (Automated Readability Index) :	10.23
SMOG :	10.75

Flesch Reading Ease : 28.09 Very difficult ; Top Academic

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Label one of each of the following quadrilaterals: square, rectangle, rhombus, parallelogram, kite and trapezium.



Grammer & Plagiarism Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

820 Tweet 272

GRADE 4 : LEARNER'S BOOK
PS Activity 3 : Extending Patterns -

SERIES 3.

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	277.00
Number of words :	62.00
Number of sentences :	8.00
Average number of characters per word :	4.47
Average number of syllables per word :	1.39
Average number of words per sentence:	7.75

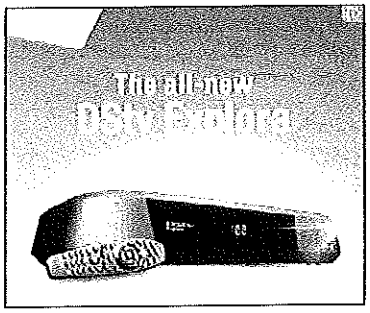
Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	3.10 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	6.64
Flesch Kincaid Grade level :	3.80
ARI (Automated Readability Index) :	3.49
SMOG :	3.00

Flesch Reading Ease : 81.62 Easy, Grade 5, 11 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Use your shapes stencil to copy the 6 triangle patterns you made with the matches.
- Build this triangle pattern with matches as shown in number 1.



Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 4 : Learner's Book
pg 297 Activity 1

824 Tweet 274

Series 4.6

This free online software tool calculates readability : Coleman Liau Index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	315.00
Number of words :	78.00
Number of sentences :	11.00
Average number of characters per word :	4.04
Average number of syllables per word :	1.46
Average number of words per sentence:	7.09

Typos ??

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	5.91 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	3.76
Flesch Kincaid Grade level :	4.42
ARI (Automated Readability Index) :	1.14
SMOG :	7.37

Flesch Reading Ease : 75.99 Fairly Easy, Grade 6, 12yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Remember: There may be no gaps between the tiles and the tiles may not overlap.
- Use more tiles to fill up any gaps inside the quadrilateral.
- Use the tile 24 times to make a tesselation in your workbook.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

GRADE 4 : LENENER'S BOOK
PS. 153 Activity 2 Typed??

820 Tweet 272

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

SERIES

4th

Number of characters (without spaces) :	359.00
Number of words :	92.00
Number of sentences :	10.00
Average number of characters per word :	3.90
Average number of syllables per word :	1.40
Average number of words per sentence:	9.20

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	5.85 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	3.92
Flesch Kincaid Grade level :	4.54
ARI (Automated Readability Index) :	1.55
SMOG :	7.24

Flesch Reading Ease : 78.87 Fairly Easy, Grade 6, 12yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Compare the number of lines of symmetry with the number of sides of the shape.
- Use a ruler to draw these lines of symmetry on the shape.
- How many lines of symmetry do you think it has?

Instant Punctuation Check

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 4 Learner's Book
PS 139 – Key ideas

SERIES 5

824 Tweet 274

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	377.00
Number of words :	98.00
Number of sentences :	14.00
Average number of characters per word :	3.85
Average number of syllables per word :	1.29
Average number of words per sentence:	7.00

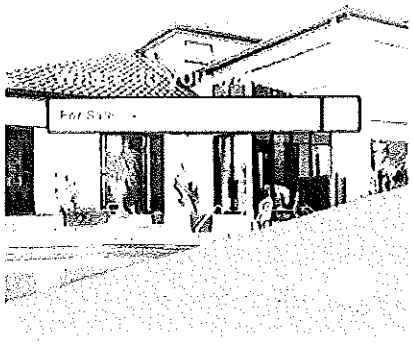
Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	3.21 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	2.57
Flesch Kincaid Grade level :	2.31
ARI (Automated Readability Index) :	0.19
SMOG :	5.54

Flesch Reading Ease : 90.96 Very Easy, Grade 4, 10 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- The step number above the number of matchsticks describes the step in the pattern.
- A shape pattern can be a repeating pattern or a growing pattern.
- The step number does not mean the number of matchsticks in that step.
- We can record the number of objects in each step in a table.



Grammer & Plagiarism Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility | English Language | Text | Math | Other

Tests Document Readability

Grade 4 : Learner's Book
Pg 65 Activity 1

820 Tweet 272

Series 5:

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Topic 22

Number of characters (without spaces) :	500.00
Number of words :	116.00
Number of sentences :	12.00
Average number of characters per word :	4.31
Average number of syllables per word :	1.42
Average number of words per sentence:	9.67

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	5.25 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	6.48
Flesch Kincaid Grade level :	4.96
ARI (Automated Readability Index) :	3.71
SMOG :	6.54

Flesch Reading Ease : 76.69 Fairly Easy, Grade 6, 12 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Marlene, John and Thembeka look at the following shapes: Their teacher asks them to group the shapes in as many ways as they can.
- Marlene put the shapes into two groups: open shapes and closed shapes.
- Thembeka put the shapes with 'no crossing lines' into three groups.

Grade 5: Series 1 - 5

Grammer & Plagiarism Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

GRADE 5 : LEARNER'S BOOK
PG 42 Explanations / Exposition

SERIES 1

820 Tweet 272

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	552.00
Number of words :	112.00
Number of sentences :	9.00
Average number of characters per word :	4.93
Average number of syllables per word :	1.61
Average number of words per sentence:	12.44

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	9.62 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	10.82
Flesch Kincaid Grade level :	8.23
ARI (Automated Readability Index) :	8.01
SMOG :	10.07

Flesch Reading Ease : 58.24 Fairly difficult ; Grades 11/12 , 17/18 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- However, if you were to take a photograph or draw a picture of a three-dimensional object, you would have a two-dimensional view of that object.
- You live in a three-dimensional world, so everything that you see around you has three dimensions:length, width (or breadth) and height.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

GRADE 5 : LEARNER'S BOOK
PG 96 Exercise 8.5 # 2a-e

SERIES 1

820 Tweet 272

This free online software tool calculates readability : Coleman Liau Index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	433.00
Number of words :	97.00 ✓
Number of sentences :	11.00
Average number of characters per word :	4.46
Average number of syllables per word :	1.46
Average number of words per sentence:	8.82

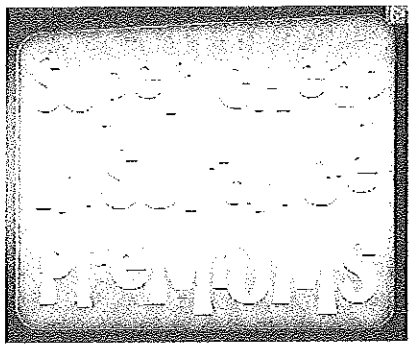
Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	6.41 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	7.09
Flesch Kincaid Grade level :	5.12
ARI (Automated Readability Index) :	4.00
SMOG :	7.67

Flesch Reading Ease : 74.04 Fairly Easy ; Grade 6 , 12 yrs.

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- On squared dotted grid paper, draw any two composite shapes made from the same basic shapes.
- Pretend that the composite shapes are real fields that you can walk around.
- Compare the reactangles used in Shapes A and Shape B.



Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 5 Learner's bk
PS 117 Exercise 1

824 Tweet 274

SERIES 2

This free online software tool calculates readability : Coleman Liau Index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	324.00
Number of words :	77.00
Number of sentences :	8.00
Average number of characters per word :	4.21
Average number of syllables per word :	1.48
Average number of words per sentence:	9.62

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	10.08 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	5.87
Flesch Kincaid Grade level :	5.63
ARI (Automated Readability Index) :	3.20
SMOG :	9.98

Flesch Reading Ease : 71.81 Fairly Easy, Grade 6, 12 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Lines of symmetry divide the shape into identical halves and can be either vertical, horizontal or diagonal.
- Symmetry is when a shape can be divided exactly in half with each half being the same.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

GRADE 5 : LEARNER'S BOOK
PS 54 'Explanation/Exposition

SERIES 2

820 Tweet 272

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	343.00
Number of words :	85.00
Number of sentences :	7.00
Average number of characters per word :	4.04
Average number of syllables per word :	1.25
Average number of words per sentence:	12.14

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	4.86

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	5.50
Flesch Kincaid Grade level :	3.86
ARI (Automated Readability Index) :	3.65
SMOG :	5.07

Flesch Reading Ease : 89.01 Easy, Grade 5, 10-11 yrs.

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- You can test to see whether shapes have right angles by using a piece of paper.
- When looking at a square or a rectangle they have something else in common.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 5 : Learner's Book
Unit 5/Term 3 week 5

SERIES 3

824 Tweet 274

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	424.00
Number of words :	112.00
Number of sentences :	17.00
Average number of characters per word :	3.79
Average number of syllables per word :	1.30
Average number of words per sentence:	6.59

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	2.99 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	1.94
Flesch Kincaid Grade level :	2.36
ARI (Automated Readability Index) :	0.31
SMOG :	4.88

Flesch Reading Ease : 89.87 Easy, Grade 5, Nyrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- g) It has two long equal sides and two short equal sides.
- f) It has two long equal sides and two short equal sides.
- Choose the correct description and write it next to each drawing.
- Draw each of the following 2-D shapes.
- h) It has eight equal sides.

Tests Document Readability

GRADE 5 : LEARNER'S BOOK
PG 107

SERIES 3

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	269.00
Number of words :	67.00
Number of sentences :	5.00
Average number of characters per word :	4.01
Average number of syllables per word :	1.33
Average number of words per sentence:	13.40

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	5.96 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	5.61
Flesch Kincaid Grade level :	5.31
ARI (Automated Readability Index) :	4.18
SMOG :	7.24

Flesch Reading Ease : 80.85 Easy, Grade 5, high

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- We can also look at patterns where a shape or part of a shape is added each time.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

GRADE 5 : LEARNER'S BOOK
PG 64 Activity 2

SERIES 4

820 Tweet 272

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	371.00
Number of words :	94.00 ✓
Number of sentences :	9.00
Average number of characters per word :	3.95
Average number of syllables per word :	1.41
Average number of words per sentence:	10.44

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	6.73 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	4.57
Flesch Kincaid Grade level :	5.18
ARI (Automated Readability Index) :	2.38
SMOG :	7.83

Flesch Reading Ease : 76.53 Fairly Easy ; Grade 6 , 12yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Look at the two-dimensional shapes below: Trace the shapes on a piece of paper and cut them out.
- Compare the number of lines of symmetry with the number of sides of the shape.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grades Learner's Book
PS 312 Explanation/Exposition

SERIES 4

824 Tweet 274

This free online software tool calculates readability : Coleman Liau Index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	541.00
Number of words :	124.00
Number of sentences :	9.00
Average number of characters per word :	4.36
Average number of syllables per word :	1.53
Average number of words per sentence:	13.78

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	10.99 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	7.72
Flesch Kincaid Grade level :	7.86
ARI (Automated Readability Index) :	6.01
SMOG :	10.75

Flesch Reading Ease : 63.22 Standard ; Grades 7/10 , 13-16 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Tesselations, that we work with, have three important features: a) The 2D shapes in a tesselation are the same and are called tiles.
- e) Tesselations Q shows rows as well as columns of shapes with one curved side, as well as pentagons.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 5 : Learners book
PG 201-202 Activity 5

SERIES 824 Tweet 274

5th

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	402.00
Number of words :	111.00
Number of sentences :	12.00
Average number of characters per word :	3.62
Average number of syllables per word :	1.14
Average number of words per sentence:	9.25

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	4.06 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	2.29
Flesch Kincaid Grade level :	1.52
ARI (Automated Readability Index) :	0.25
SMOG :	4.58

Flesch Reading Ease : 100.65 Very Easy ; Grade 4, 10 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Is the angle bigger than or smaller than a right angle?
- Is the angle bigger than or smaller than a right angle?
- You have made an angle between the hands of the clock.

Tools Document Readability

GRADE 5's LEARNER'S BOOK
PG 59 Key idea / Explanation / Exposition

SCORES 5

820 Tweet 272

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	542.00
Number of words :	134.00
Number of sentences :	12.00
Average number of characters per word :	4.04
Average number of syllables per word :	1.30
Average number of words per sentence:	11.17

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	4.77 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	5.34
Flesch Kincaid Grade level :	4.09
ARI (Automated Readability Index) :	3.20
SMOG :	4.58

Flesch Reading Ease : 85.65 Easy / Grade 5 / 11 yrs.

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- We look at angles that are right angles, greater than right angles and smaller than right angles.
- We can use an arrow to show how the arm of the turner was moved to make an angle.
- Think about angles at the corners of triangles, squares, stars, boxes, doors and pages.

Grade 6: Series 1 - 5

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 6 Learners book
Pg 138 Exercise 22.2 #1

824 Twist 274

SERIES 1

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	482.00
Number of words :	113.00
Number of sentences :	9.00
Average number of characters per word :	4.27
Average number of syllables per word :	1.42
Average number of words per sentence:	12.56

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading

Gunning Fog index :	8.56 ✓ use??

Approximate representation of the U.S. grade level needed to comprehend the text :

Coleman Liau index :	6.93
Flesch Kincaid Grade level :	6.01
ARI (Automated Readability Index) :	4.94
SMOG :	9.06 →

Flesch Reading Ease : 74.30 → Fairly Easy; Grade 6 ; 12 yrs ✓

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- This type of butterfly is known as the owl butterfly because the two markings on the wings look like an owl's eyes.
- c) Find a picture of an object or a shape with a pattern that uses this type of transformation.

Tests Document Readability

Grade 6 Learner's book
pg 40 Exercise 6.5 #2

SERIES 1.0

824 Tweet 274

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	436.00
Number of words :	102.00
Number of sentences :	11.00
Average number of characters per word :	4.27
Average number of syllables per word :	1.44
Average number of words per sentence:	9.27

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	6.85 ✓

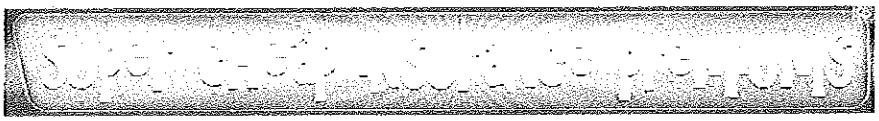
Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	6.14
Flesch Kincaid Grade level :	5.03
ARI (Automated Readability Index) :	3.34
SMOG :	7.95

Flesch Reading Ease : 75.50 — Fairly Easy; Grade 6, 12yrs ✓

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- I you think a shape is possible, draw a neat clear sketch of the shape on grid paper.
- a quadrilateral with all four angles smaller than a right angle f.
- a parallelogram with opposite angles that are not equal

Online-Utility.org
Utilities for Online Operating System



Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 6 Learner's Book
PS 71 Exercise 2

Series 2

624 Tweet 274

This free online software tool calculates readability : Coleman Liau Index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	403.00
Number of words :	99.00
Number of sentences :	11.00
Average number of characters per word :	4.07
Average number of syllables per word :	1.33
Average number of words per sentence:	9.00

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	6.43 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	4.84
Flesch Kincaid Grade level :	3.65
ARI (Automated Readability Index) :	2.24
SMOG :	7.67

Flesch Reading Ease : 84.90 → Easy ; Grade 5 ; 11 yrs ✓✓

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Reading the pattern from left to right, each hexagon has one more match on each side than the hexagon on the left.
- Geometric patterns are made up of shapes that keeps their form while their size changes.
- A description of the pattern: It is a pattern of hexagons.

Instant Grammar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 6 Learners Book
PS 198 Exercise 1

824 Tweet 274

Series 2.

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	413.00
Number of words :	101.00
Number of sentences :	16.00
Average number of characters per word :	4.09
Average number of syllables per word :	1.31
Average number of words per sentence:	6.31

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog Index :	3.71 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	3.53
Flesch Kincaid Grade level :	2.29
ARI (Automated Readability Index) :	0.99
SMOG :	6.62

Flesch Reading Ease : 89.86 Easy; Grade 5; Hyp ✓✓

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Every side must be enlarged or reduced by the same multiple.
- In geometry, when you enlarge shape, use this method: 1.
- On your grid paper, draw the next enlargement.
- It is still a square but it now covers 4 blocks.

Instant Gramar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 6 Leanus Gale
PS 153

824 Tweet 274

SERIES 3

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	515.00
Number of words :	133.00
Number of sentences :	22.00
Average number of characters per word :	3.87
Average number of syllables per word :	1.30
Average number of words per sentence:	6.05

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	4.82 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	2.04
Flesch Kincaid Grade level :	2.12
ARI (Automated Readability Index) :	0.17
SMOG :	6.30

Flesch Reading Ease : 90.66 Very Easy, Grade 4, 10y/s

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Write only the letters a to j and next to each letter write whether the statements below are True of False.
- The distance from the centre of a circle to the circumference of a circle is not always the same.
- A prallelogram has opposite sides equal and parallel.
- Draw two columns in your book and write True and False at the top.
- The opposite sides of a square are equal in length.
- A circle is twice as big as a semi-circle.

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 6 Learners Book
pg 40 Activity 4 Exercise 1

SERIES 3

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	447.00
Number of words :	125.00
Number of sentences :	26.00
Average number of characters per word :	3.58
Average number of syllables per word :	1.31
Average number of words per sentence:	4.81

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	2.24 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	0.98
Flesch Kincaid Grade level :	1.77
ARI (Automated Readability Index) :	2.18
SMOG :	4.07

Flesch Reading Ease : 90.96 Very Easy, Grade 4, 10 yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Use your shapes stencil to draw each of the 2-D shapes.
- It has 2 long equal sides and 2 short equal sides.
- It has 2 long equal sides and 2 short equal sides.
- Write the correct description for each shape.
- It has 4 straight equal sides.
- It has 3 straight equal sides.
- It has 8 equal straight sides.

Instant Grammar Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 6 : Learners Book pg 224 Explanation / Exp 10

824 Tweet 274

Series 4

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	521.00
Number of words :	110.00
Number of sentences :	6.00
Average number of characters per word :	4.74
Average number of syllables per word :	1.57
Average number of words per sentence:	18.33

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	10.61 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	10.46
Flesch Kincaid Grade level :	10.12
ARI (Automated Readability Index) :	10.04
SMOG :	10.07

Flesch Reading Ease : 55.17 Fairly difficult ; 9th/10th Grades) 15-16 yrs'

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- the types of their angles, which can be acute angles (less than a quarter turn), right angles (a quarter turn), obtuse angles (between a quarter and a half turn) and reflex angles (between a half turn and a revolution).

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

Grade 6 : Learners Book
P68 Activity 10 Exercises 1a, b; 2a, b, c;

SERIES 4

824 Tweet 274

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

3, 4, 5; 6, 7.

Number of characters (without spaces) :	408.00
Number of words :	99.00 (87)
Number of sentences :	19.00
Average number of characters per word :	4.12
Average number of syllables per word :	1.44
Average number of words per sentence:	5.21

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	4.91 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	2.72
Flesch Kincaid Grade level :	3.49 ✓
ARI (Automated Readability Index) :	0.59
SMOG :	6.55

Flesch Reading Ease : 79.35 Fairly Easy, Grade 6 & 12yrs

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- equal opposite sides, two acute angles and two obtuse angles.
- Draw an octagon of which all sides are five units long.
- Draw a hexagon of which all sides are five units long.
- Draw a heptagon with all its angles obtuse angles.
- equal opposite sides and four right angles c.

Free Check for Plagiarism

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

GRADE 6 : LEARNERS BK
PG 317. ACTIVITY | EXERCISE 2 @ - (d)

SERIES

5.

824 Tweet 274

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	372.00
Number of words :	97.00 ✓
Number of sentences :	8.00
Average number of characters per word :	3.84
Average number of syllables per word :	1.35
Average number of words per sentence:	12.12

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	6.91 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau Index :	4.31
Flesch Kincaid Grade level :	5.07
ARI (Automated Readability Index) :	2.70
SMOG :	8.12

Flesch Reading Ease : 80.27 Easy ; Grade 5 ; 11yrs'

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Compare the areas of the original shapes to the areas of the reduced shapes.
- Work out the area of each shape and its reduction in number of squares.

Grammer & Plagiarism Checker

Online-Utility.org
Utilities for Online Operating System

Online Utility **English Language** **Text** **Math** **Other**

Tests Document Readability

GRADE 6 & LEARNER'S BOOK
PG 197 Activity 3 Exercise 2 ☺

SERIES
5.

824 Tweet 274

This free online software tool calculates readability : Coleman Liau index, Flesch Kincaid Grade Level, ARI (Automated Readability Index), SMOG. The measure of readability used here is the indication of number of years of education that a person needs to be able to understand the text easily on the first reading. Comprehension tests and skills training.
This tool is made primarily for English texts but might work also for some other languages. In general, these tests penalize writers for polysyllabic words and long, complex sentences. Your writing will score better when you: use simpler diction, write short sentences.
It also displays complicated sentences (with many words and syllables) with suggestions for what you might do to improve its readability.

Number of characters (without spaces) :	372.00
Number of words :	89.00 ✓
Number of sentences :	7.00
Average number of characters per word :	4.18
Average number of syllables per word :	1.30
Average number of words per sentence:	12.71

Indication of the number of years of formal education that a person requires in order to easily understand the text on the first reading	
Gunning Fog index :	6.43 ✓

Approximate representation of the U.S. grade level needed to comprehend the text :	
Coleman Liau index :	6.46
Flesch Kincaid Grade level :	4.75
ARI (Automated Readability Index) :	4.61
SMOG :	7.14

Flesch Reading Ease : 83.66 Easy) Grade 5, 11 yrs.

List of sentences which we suggest you should consider to rewrite to improve readability of the text :

- Use a ruler to draw a line from the centre of the circle to the outside line (circumference) of the circle.
- Use your pair of compasses to draw another smaller circle inside your circle.

APPENDIX K:

2012: Invitation and terms of reference to submit learning and teaching support materials for evaluation and adoption in the national catalogue, Department of Basic Education, South Africa.

2012: Invitation and Terms of Reference to Submit Learning and Teaching Support Material for Evaluation and Adoption in the National Catalogue, Department of Basic Education, South Africa

INTRODUCTION

The 2012 Invitation and Terms of Reference (TOR) to Submit Learning and Teaching Support Material (LTSM) for Evaluation and Adoption in National Catalogue of the Department of Basic Education (DBE), initiates the evaluation and adoption of LTSM in select subject categories for use in South African public schools. This document, including all attachments, provides for functionality and price, giving an overview of the process for submission, evaluation, and adoption of LTSM. By submitting LTSM for evaluation, publishers and producers agree to follow the procedures set forth in these Terms of Reference (TOR). Failure to comply with all procedures, including stated deadlines, will result in disqualification for the evaluation and adoption process.

The National Catalogue will provide a listing of all Core LTSM approved for use in South African public schools, available for procurement by all provincial education departments and schools (with a function to procure LTSM in terms of Section 21 of the South African Schools Act, 84 of 1996). It will provide a maximum of eight options per subject in a particular language for a grade, from which schools can select the most appropriate material for their context.

The 2012 evaluation will include the Core LTSM categories listed under Heading 3. On all submissions publishers must designate each specific category for which a submission is to be evaluated.

SPECIAL CONDITIONS OF CONTRACT (SCC)

This invitation and terms of reference sets out an framework agreement between the Department of Basic Education and publishers for the supply of LTSM for Grades 4 – 6 and Grade 11 to be included in the National Catalogue which will serve for a period of three years. It sets the price for books but does not guarantee their purchase.

1. Submission Parameters

1. Publishing companies are limited to no more than four submissions per category for each language. A publishing company is deemed to be a registered legal entity and not a publishing imprint. **It is compulsory for each publishing company to submit a valid tax clearance certificate from SARS when they submit their materials for screening. Failure to submit a tax certificate will render their submissions incomplete and they will therefore be disqualified.**

2. Material for Intermediate Phase must cover all three grades, i.e. Grades 4, 5 and 6 in a particular language for a subject. Material will not be accepted for only one of these grades.

3. All textbooks must have an accompanying Teacher Guide, in the same language as the textbook.

4. Publishers are responsible for stipulating the correct category of the submission. See Heading 2 for categories of submission.

5. On registration publishers must provide full and final title, authors' names, prices and ISBN, as it should appear on the catalogue. **If prices are not provided on registration the submission will be disqualified. After the scheduled window period for correcting data there will be no opportunities to change the price.**

6. It is the responsibility of the publisher to ensure that each submission is complete and that the sample material is delivered to the designated site.

7. All submissions must be anonymous. The book cover should include a code provided by the DBE on registration, in addition to stating the subject, grade and language. The book cover should be white with black print. Author names, title, publisher imprint and publisher details must not appear at all in the material submitted for evaluation. This includes inserts which might be included with a book, such as Compact Discs.

8. The evaluation is limited to print material. However, for Computer Applications Technology and Information Technology, additional electronic material can be submitted along with the print material as an insert to the print material.

9. Each submission must contain an attached identification sheet, which includes: category of submission, publishers details, contact person (including email address and telephone number), ISBN, full title, code, names of all authors, and number of copies. See Annexure A for sample identification sheet.

10. Each submission should be packaged in a separate container. The category of submission must be clearly indicated on the exterior of each container, in addition to an identification sheet being included inside the container (see Annexure A for a sample identification sheet). The DBE reserves the right to specify the dimensions of the cardboard boxes prior to the submission dates.

11. Publishers of titles accepted for inclusion on the National Catalogue will be obligated to lodge 10 copies of the final version of each accepted title with the DBE.

12. Stated prices should include all discounts and include VAT. Provinces would need to add the cost of the distribution of the LTSM onto the prices.

2. CATEGORIES OF LTSM FOR SUBMISSION IN 2012

Intermediate Phase: Grades 4, 5 and 6		
Category	**Description**	**Number of Submission Copies Required**
IP-1	Home Language: Textbook, Core Reader and Teacher's Guide	6 Textbooks, 6 Core Readers and 6 Teacher's Guides
IP-2	Home Language: Graded Readers	6 Copies
IP-3	First Additional Language: Textbook, Core Reader and Teacher's Guide	6 Textbooks, 6 Core Readers and 6 Teacher's Guides
IP-4	First Additional Language: Graded Readers	6 Copies
IP-5	Life Skills: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
IP-6	Mathematics: Textbook and Teacher's Guide *	6 Textbooks and 6 Teacher's Guides
IP-7	Natural Sciences and Technology: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
IP-8	Social Sciences: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides

Grade 11		
Category	Description	Number of Submission Copies Required
GR11-1	Home Language: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-2	First Additional Language: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-3	Second Additional Language: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-4	Accounting: Textbook, Exercise Book and Teacher's Guide	6 Textbooks, 6 Exercise Books and 6 Teacher's Guides
GR11-5	Agricultural Management Practices: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-6	Agricultural Science: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-7	Agricultural Technology: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-8	Business Studies: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-9	Civil Technology: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-10	Computer Applications Technology: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-11	Consumer Studies: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-12	Dance Studies: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-13	Design: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-14	Dramatic Arts: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-15	Economics: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-16	Electrical Technology: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-17	Engineering Graphics and Design: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-18	Geography: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-19	History: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-20	Hospitality Studies: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-21	Information Technology: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-22	Life Orientation: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-23	Life Sciences: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-24	Mathematical Literacy: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-25	Mathematics: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-26	Mechanical Technology: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-27	Music: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-28	Physical Sciences: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-29	Religion Studies: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-30	Tourism: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides
GR11-31	Visual Arts: Textbook and Teacher's Guide	6 Textbooks and 6 Teacher's Guides

Note on categories:

See Annexure C for more information on Textbooks, Core Readers, Graded Readers and Teacher Guides.

Submissions must strictly comply with the above categories and will only be accepted for the full category. For example: a Textbook without a Teacher's Guide will be deemed to be an incomplete submission, Textbooks and Teacher's Guides for grades 4 and 5 but not for grade 6 will constitute an incomplete submission, an Intermediate Phase Language Teacher's Guide and Textbook without a Core Reader will be considered an incomplete submission.

A submission is deemed to be complete if on submission the following are provided:

- *Proof of payment;*
- *ISBN for all components as submitted during registration;*
- *The correct number of copies of the submission as set out in the invitation;*
- *The correct components per submission;*
- *A valid tax clearance certificate from the publishing company.*

Incomplete submissions will be disqualified and will not be screened or considered for inclusion in the national catalogue.

3. SUBMISSION DATES

Submissions for **Grade 11** will **not be accepted** before 9am on **13 February 2012** and after 5pm on **20 February 2012.**

Submissions for **Intermediate Phase**, i.e. Grades 4, 5 and 6, for the following subjects: Mathematics, Natural Sciences and Technology, Life Skills and Social Sciences **will not be accepted** before 9am on **5 March 2012** and after 5pm on **9 March 2012.**

Submissions for **Intermediate Phase**, i.e. Grades 4, 5 and 6, for the following subjects: Home Language and First Additional Language will not be accepted before 9am on **12 March 2012** and after 5pm on **16 March 2012.**

An outline of the submission process timeframes is attached (see Annexure B).

4. SUBMISSION FEE

A non-refundable submission fee of R2 000 will be payable for each submission per category for each grade. Therefore should a submission cover 3 grades, this amounts to R6 000.

FUNCTIONALITY AND PRICE

5. SCREENING PROCESS

The following criteria will form the basis of the evaluation process:

1. Curriculum Content: is the textbook aligned to the curriculum in terms of content, sequencing and progression of content?
2. Content Analysis - in sample sections of a text, is the pedagogic approach in the textbook/teacher's guide based on sound understanding of how learning takes place?
3. Instructional Design - are the activities well formulated and clearly support the learning goals?
4. Level- do activities make appropriate levels of cognitive demand on learners and use appropriate language for the grade?

5. Constitutional Values - does the textbook communicate values and attitudes consistent with the South African constitution? For example, does the material convey and promote an appreciation of human rights, a healthy environment, social justice and inclusivity?
6. Design quality- is the textbook attractive, accessible and engaging for the learners?
7. Fitness for Purpose- is the textbook designed to meet its intended purpose?

Submissions will be rated against these broad criteria by specialist screening teams for each subject. Where more than eight titles are submitted for a subject in a particular language, the eight top ranked titles for that subject and language will be recommended for final confirmation in the National Catalogue. Where fewer than eight titles are considered of appropriate quality, the number for final confirmation will be less than eight.

Categories of recommendation in the screening process will be limited to:

1. Conditionally Accepted: This will comprise of more than ten titles deemed appropriate for inclusion in the National Catalogue, using a ranking system where relevant, and include some titles that might need minor refinement. On resubmission the requested refinements will be evaluated to adjudicate the highest ranked eight titles.

2. Not Accepted: This will apply where the submission is assessed to not meet all criteria or/and is not rated among the top ten submissions for a subject and in a particular language.

6. Appeals Process

Appeals will be limited to instances where an error has occurred in the first screening process as evidenced by the publishers' report. For example, a topic is mistakenly claimed to be omitted from a text or a factual error is reported but there is current scientific evidence to the contrary. No appeals will be allowed after the rescreening process. The appeals committee will be limited to adjudication on the substance of the appeal. Where the appeals committee overturns the decision of the screening committee the submission will be rescreened and be eligible to be added to the Conditionally Accepted list or the Not Accepted list should it not meet criteria or not be rated sufficiently high.

The appeals committee will be established by the DBE, comprising subject specialists and departmental officials. Its decision on appeals will be considered final.

7. Prices of titles on the catalogue

Publishers are required to provide the best unit price per item on registration. Prices must include VAT but exclude distribution cost, for the following quantities: 1 to 10 000 copies, 10 000 to 25 000 copies, 25 000 to 50 000 copies, 50 000 to 100 000 copies, over 100 000 copies. These prices should be seen as the ceiling price and will be applicable for a period of three years. The DBE reserves the right to re-negotiate for lower than the ceiling price with publishers whose books are on the catalogue.

The titles in the final catalogue will be ranked according to the price, per price band, provided by the publishers on registration.

8. EXCEPTIONAL CONDITIONS

The DBE reserves the right to:

(a) call for a resubmission in areas of scarce resources, where few submissions of appropriate quality are received for a particular subject in a certain language.

(b) purchase and distribute additional LTSM for use in schools from sources other than the National Catalogue.

(c) select certain books from the catalogue to be brailled for use by blind/visually impaired learners in schools, after consultation with publishers.

9. CONFLICT OF INTEREST

To manage any potential conflict of interest and limit undue influence each screening committee member will be required to sign an affidavit declaring that they have no vested interest in LTSM development; be it as an author or beneficiary from a publishing company. Furthermore, it will include an undertaking to report approaches by LTSM developers, be it companies or authors, during the screening process.

Any publishing company or author found to be seeking to influence the evaluation process will be reported to the National Treasury and could, in terms of National Treasury's processes, be barred from doing business with government in future.

10. QUERIES

All queries related to this document and the process outlined herein should be submitted via the email address: Grade45611LTSM@dbe.gov.za

11. COMPULSORY BRIEFING

A compulsory briefing with the publishers and publishers' associations will be held on Thursday 5 January 2012.

Annexure A: Identification Sheet (To accompany submissions per container)

Department of Basic Education: 2012 Learning and Teaching Support Material Submission

Language: .....

Category of submission: .....

Publisher's imprint for this submission: .....

Publisher's legal registration: .....

Contact person (Name, tel. number and email address): .....

Full title for material in this container: .....

.....

Code used on submission: .....

ISBN's for material in this container: .....

.....

Full names of all authors: .....

Number of copies in this container: .....

For submissions which require multiple containers:

Container ..... of ..... for submission number ..... for category..... .

Annexure B: Submission Timeframes

2012 Submission and Screening Timeframes				
	GRADE 11		GRADES 4-6	
Process	**Start**	**End**	**Start**	**End**
Invitation submit material issued		15 Dec 2011		15 Dec 2011
Briefing to publishers and publishers' associations		5 Jan 2012		5 Jan 2012
Electronic Registration of Submissions	9 Jan 2012	13 Jan 2012	9 Jan 2012	13 Jan 2012
Window period for corrections of all data on registered submissions	23 Jan 2012	27 Jan 2012	23 Jan 2012	27 Jan 2012
Payment for submissions	30 Jan 2012	03 Feb 2012	30 Jan 2012	03 Feb 2012
Submission date for Grade 11	13 Feb 2012	20 Feb 2012		
Submission date for Intermediate Phase: Mathematics, Natural Sciences and Technology, Life Skills and Social Sciences			5 Mar 2012	9 Mar 2012
Submission date for Intermediate Phase: Home Language and First Additional Language			12 March 2012	16 March 2012
Screening process	12 Mar 2012	20 Mar 2012	26 Mar 2012	26 Apr 2012
Release of reports	30 Mar 2012	06 Apr 2012	7 May 2012	11 May 2012
Lodging of Appeals	09 Apr 2012	13 Apr 2012	14 May 2012	18 May 2012
Resubmission of conditionally accepted titles	09 Apr 2012	20 Apr 2012	11 May 2012	25 May 2012
Release appeals review reports	23 Apr 2012	24 Apr 2012	28 May 2012	30 May 2012
Resubmission of appealed titles	25 Apr 2012	10 May 2012	31 May 2012	12 Jun 2012
Rescreening	11 May 2012	18 May 2012	13 Jun 2012	19 Jun 2012
Release final screening reports	28 May 2012	29 May 2012	25 Jun 2012	27 Jun 2012

Annexure C: Guidelines for Learning and Teaching Support Material Development and Submission

The following are broad guidelines:

1. **Core Readers for Home and First Additional Language: a single reader containing all the genre required for the grade**

HOME LANGUAGE:

- The CAPS for Home Language prescribes five genre for each grade from grades 4 – 6 (folklore, poetry, drama, novel and short story) in addition to information, social and media texts.
- The Home Language core reader should contain texts for each genre and for information and media texts sufficient to cover a year's work according to the CAPS programme. Additional examples can provide schools with some freedom of choice.
- The use of colour should be confined to instances where it enhances the meaning of the text and learner engagement.

The following texts are thus suggested in each grade:

	Folklore	Short stories	Novel	Drama (a short play)	Poetry	Information texts	Media texts
Grade 4	3 (3-4 pages each)	4 (3-4 pages each)	1 (+/- 20 pages)	2 (6-9 pages each)	5 -10 poems	8 (1-2 pages each)	2*
Grade 5	4 (3-5 pages each)	4 (3-5 pages each)	1 (+/- 25 pages)	2 (7-10 pages each)	5 -10 poems	8 (1-2 pages each)	2*
Grade 6	4 (4-5 pages each)	3 (4-5 pages each)	2 (+/- 30 pages each)	3 (8-10 pages each)	5 -10 poems	8 (1-2 pages each)	2*

* Length according to the type of text

FIRST ADDITIONAL LANGUAGE:

- The CAPS for First Additional Language prescribes five genre for each grade from grades 4 – 6 (folklore, poetry, drama, novel and short story).
  - The First Additional Language class reader should contain sufficient texts for each genre to cover a year's work according to the CAPS programme as well as additional examples to provide schools with some freedom of choice.
  - The use of colour should be confined to instances where it enhances the meaning of the text and learner engagement.

The following texts are thus suggested in each grade:

	Stories	Drama (dialogue)	Poetry	Information texts	Social texts	Media texts
Grade 4	8 (2-3 pages each)	2 (3-6 pages each)	5 -10 poems	8 (1 page each)	4*	3*
Grade 5	8 (3-4 pages each)	2 (4-6 pages each)	5 -10 poems	8 (1-2 pages each)	4*	3*
Grade 6	8 (3-5 pages each)	2 (5-8 pages each)	5 -10 poems	8 (1-2 pages each)	4*	3*

* Length according to the type of text

2. Graded Readers

CAPS indicates that guided, group reading be undertaken in both the Home and First Additional Language. Graded readers comprise of a set of readers containing 12 – 20 readers with 32 – 48 pages in each. The readers should be illustrated; the use of full colour is preferred for higher levels of learner engagement. The readers should provide both fiction and non-fiction texts, have a high interest level and cover a spread of topics that cater for all contexts. The readers must be graded in complexity. Each story should be followed by 3 – 5 questions for group discussion.

3. Textbooks

A textbook should:

- Focus on teaching the concepts and communicate the knowledge stated in the relevant CAPS document.
- Be at an appropriate reading level for the intended grade.
- Include a clear explanation of new terms and use them a few times in well constructed sentences to ensure learners understand the context and use of the new vocabulary.
- Include activities that have clear instructions, be easy to understand and not require costly equipment.
- Be organised in a way that provides a structured, well-paced and sequenced learning plan for the grade.

- Be easy to navigate, through the use of headings, subheadings, captions and labels for diagrams etc.
- Include the use of colour to support the clarity of representation, as opposed to being decorative, while the font should be clear and readable.

4. Teacher's Guides

A Teacher's Guide should include the following:

- A clear contents page – listing units/modules/chapters with page references

The Introduction including:

- An overview of the CAPS
- Assessment with specific reference to the subject; the information on assessment must be appropriate/relevant to the particular subject. Merely extracting the information on assessment from the Policy documents is not adequate.
- How the Teacher's Guide should be used

Units/modules/chapters containing

- An overview of the Unit
- Step-by-step guidelines on how to implement the activity. These need to be in sufficient detail to enable the teacher to implement the activity. However they need to be flexible so that teachers can easily adjust the activity to suit their learners' needs
- Clear references to the use of other components (page referencing to activities in the Textbook and the Core Reader)
- Useful background knowledge to increase teacher's understanding of key concepts.
- Assessment: Information on what can be assessed and how; publishers need to provide teachers with a framework for assessment for the year although it will be up to the individual teacher to make the final decision on the assessment he/she will use in the classroom;
- Suggestions for extension/remedial activities may also be included

General Points: the Teacher's Guide must:

- Be written in user-friendly language
- Have an appropriate and user-friendly design and layout
- Encourage critical thinking and metacognitive strategies
- Provide the teacher with sufficient learner-tasks, to enable the learner to achieve the requirements of the CAPS
- Learner-tasks should be appropriate for the level of learners in terms of grade level, language, knowledge, skills and concepts
- Reflect the pedagogic principles contained in the CAPS
- Show a balance between individual, pair, group and class activities
- Reflect the values stated in the Constitution e.g. sensitivity to gender, race, culture and religion
- Clearly explain the assessment within the activity/unit

APPENDIX L:

Department of Basic Education (DBE): Evaluation form for learning and teaching support materials

DEPARTMENT OF BASIC EDUCATION

EVALUATION FORM FOR LEARNING AND TEACHING SUPPORT MATERIAL

FORM MUST BE COMPLETED IN BLOCK LETTERS IN BLACK PEN.

ALL SECTIONS INCLUDING "MOTIVATIONS" SHOULD BE COMPLETED IN FULL.

DATE		CATEGORY OF SUBMISSION	
	PACK ID OF ITEM SCREENED		
	GRADE		
	SUBJECT		
	LANGUAGE		
	LANGUAGE LEVEL (HL or FAL)		
	ISBN NUMBERS		

PART I: Compliance with Curriculum and Assessment Policy Statement (CAPS)

Please provide a rating score based on the scale provided below and motivate your rating in the space provided. Cite specific page numbers, CAPS content/concepts/skills as well as textual references to substantiate the motivation. Use additional sheets as necessary.

CURRICULUM CONTENT	RATING SCORE
Materials present the main content/concepts/skills that support the instructional objectives for the subject and grade in the CAPS. Content is well presented and scaffolded.	
Motivation:	

GUIDELINES FOR USING KNOWLEDGE AND CONTENT RATING SCALE

KNOWLEDGE AND CONTENT		
Score	**Descriptors**	**Key/Comment**
9-10	Excellent	• All relevant information & subject content appropriate for the grade has been included • All content and skills are presented in a format that : ✓ provides understanding and clear insight that underpin the knowledge; ✓ is well scaffolded and structured (e.g. from known to unknown or concrete to abstract, or builds on prior knowledge presented in the material) ✓ will enable the learner to acquire and apply concepts and skills in different situations.
7-8	Good	• ***Most*** relevant information and subject content appropriate for the grade has been included • ***Most*** content and skills are presented in a format that : ✓ provides understanding and clear insight that underpin the knowledge; ✓ is well scaffolded and structured (e.g. from known to unknown or concrete to abstract, or builds on prior knowledge presented in the material) ✓ that will enable the learner to acquire and apply concepts and skills in different situations
5-6	Satisfactory	• ***Only some*** relevant information and subject content appropriate for the grade has been included • ***Only some*** content/topics is presented in a fashion that : ✓ provides understanding and clear insight that underpin the knowledge; ✓ is well scaffolded and structured (e.g. from known to unknown or concrete to abstract, or builds on prior knowledge presented in the material) ✓ will enable the learner to acquire and apply concepts and skills in different situations
1-4	Unsatisfactory	• No link or very little information related to the subject content • Content is irrelevant and inappropriate for the grade • Not well scaffolded and structured (e.g. from known to unknown or concrete to abstract, or builds on prior knowledge presented in the material)

PART II: CONTENT ANALYSIS

The content analysis is based on a sample topic in the text, where the goal is to assess how a topic is presented pedagogically.

Please provide a rating score based on the scale provided below and motivate your rating in the space provided. Cite specific page numbers, CAPS content/concepts/skills as well as textual references to substantiate the motivation. Use additional sheets as necessary.

CONTENT ANALYSIS	RATING SCORE
The pedagogical approach is sound and will engage learners, while the content is accurate and well explained.	
Motivation:	

GUIDELINES FOR CONTENT ANALYSIS RATING SCALE

CONTENT ANALYSIS		
Score	**Descriptors**	**Key/Comment**
9-10	Excellent	• The topic is accurately described in terms of the current disciplinary understanding. • The pedagogic approach in the textbook is based on a sound understanding of how learning takes place; • The topic is presented in a way that: ✓ will engage learners and provide clear understanding of the topic; ✓ the visuals/illustrations will enhance learners' understanding of the topic; ✓ will enable the learner to acquire and apply concepts and skills in different situations.
7-8	Good	• The topic is ***mostly*** accurately described in terms of the current disciplinary understanding. • The pedagogic approach in the textbook is ***mostly*** based on a sound understanding of how learning takes place; • The topic is ***mostly*** presented in a way that: ✓ will engage learners and provide clear understanding of the topic; ✓ the visuals/illustrations will enhance learners' understanding of the topic; ✓ will enable the learner to acquire and apply concepts and skills in different situations.
5-6	Satisfactory	• ***Only some*** of the topic is accurately described in terms of current disciplinary understanding. • ***Only some*** of the pedagogic approach in the textbook is based on a sound understanding of how learning takes place; • ***Only some*** of the topic is presented in a way that: ✓ will engage learners and provide clear understanding of the topic; ✓ the visuals/illustrations will enhance learners' understanding of the topic; ✓ will enable the learner to acquire and apply concepts and skills in different situations.
1-4	Unsatisfactory	• The topic is ***not*** accurately described in terms of the current disciplinary understanding. • The pedagogic approach in the textbook is ***not*** based on a sound understanding of how learning takes place; • The topic is mostly presented in a way that is ***unlikely*** to: ✓ engage learners or provide clear understanding of the topic; ✓ enhance learners' understanding of the topic through the use of visuals/illustrations; ✓ enable the learner to acquire and apply concepts and skills in different situations.

PART III: ACTIVITIES AND ASSESSMENT

In evaluating the activities and assessment please relate them to the topic coverage in the text.

Please provide a rating score based on the scale provided below and motivate your rating in the space provided. Cite specific page numbers, CAPS content/concepts/skills as well as textual references to substantiate the motivation. Use additional sheets as necessary.

ACTIVITIES AND ASSESSMENT	RATING SCORE
Activities and assessment are clear and will be engaging for learners in this grade. They are clearly related to the topic coverage and provide for interesting variety, while being clearly scaffolded.	
Motivation:	

GUIDELINES FOR USING ACTIVITIES AND ASSESSMENT RATING SCALE

Score	Description	Key/Comment
9-10	Excellent	• ***All activities*** well-thought through, clear, unambiguous activities and addresses **all** cognitive levels • ***A variety of*** activities that is **sufficient** for daily class work practice and assessment that address content and skills. • ***All*** activities are well scaffolded, paced and structured (e.g. easy to complex) • ***All*** activities are engaging and enable learners to consolidate content, concepts and skills and stimulate critical thinking.
7-8	Good	• **Most** activities are well-thought through, clear, unambiguous and addresses **most** cognitive levels • **Not enough variety** of activities for daily class work practice and assessment that address content and skills. • ***Most*** activities are well scaffolded, paced and structured (e.g. easy to complex) • ***Most activities*** are engaging and enable learners to consolidate content, concepts and skills and stimulate critical thinking.
5-6	Satisfactory	• Activities address **some** cognitive levels, lack variety or not always well-thought through or not clear. • **Some** activities can be used for daily class work practice and assessment that address content and skills. • **Some** activities are scaffolded, paced and structured (e.g. easy to complex) • **Some** activities are engaging and enable learners to consolidate content, concepts and skills and stimulate critical thinking.
1-4	Unsatisfactory	• **Only Few** activities are relevant and appropriate for the grade level. • **Only Few** Activities are scaffolded, paced and structured. • **Only few activities** can be used for daily class work practice and assessment as most are unsuitable, repetitive and boring for most learners.

PART IV: LEVEL

Please provide a rating score based on the scale provided below and motivate your rating in the space provided. Cite specific page numbers, CAPS content/concepts/skills as well as textual references to substantiate the motivation. Use additional sheets as necessary.

LEVEL	**RATING SCORE**
The level of writing and explanation is appropriate for learners of this grade level.	
Motivation:	

GUIDELINES FOR USING LEVEL RATING SCALE

LEVEL		
Score	**Descriptors**	**Key/Comment**
9-10	Excellent	• All of the text is well written in language that is relevant and appropriate for the grade. • All of the text is presented in a manner that : ✓ is relevant to South African learners of this age group ✓ provides understanding and clear insight appropriate for the age group ✓ will enable the learner to acquire and apply sufficient vocabulary and knowledge relevant to the subject
7-8	Good	• *Most* of the text is well written in language that is relevant and appropriate for the grade. • *Most* of the text is presented in a manner that : ✓ is relevant to South African learners of this age group ✓ provides understanding and clear insight appropriate for the age group ✓ will enable the learner to acquire and apply sufficient vocabulary and knowledge relevant to the subject
5-6	Satisfactory	• *Only some* of the text is well written in language that is relevant and appropriate for the grade. • *Only some* of the text is presented in a manner that : ✓ is relevant to South African learners of this age group ✓ provides understanding and clear insight appropriate for the age group ✓ will enable the learner to acquire and apply sufficient vocabulary and knowledge relevant to the subject
1-4	Unsatisfactory	• Text is too difficult/easy for learners of this grade level. • Explanations are not clear or appropriate for the grade level.

PART V: VALUES

Please provide a rating score based on the scale provided below and motivate your rating in the space provided. Cite specific page numbers, CAPS content/concepts/skills as well as textual references to substantiate the motivation. Use additional sheets as necessary.

VALUES	RATING SCORE
The text is appropriate for learners in a diverse society and promotes social transformation.	
Motivation:	

GUIDELINES FOR USING VALUES RATING SCALE

Relevance		
Score	**Descriptors**	**Key/Comment**
9-10	Excellent	• All of the text is suitable for South African learners in diverse school contexts. • All of the text is presented in a manner that : ✓ demonstrates an appreciation of cultural and racial diversity; ✓ provides positive gender representation; ✓ shows an appreciation of indigenous knowledge systems; ✓ shows an appreciation of environmental sustainability.
7-8	Good	• *Most* of the text is suitable for South African learners in diverse school contexts. • *Most* of the text is presented in a manner that : ✓ demonstrates an appreciation of cultural and racial diversity; ✓ provides positive gender representation; ✓ shows an appreciation of indigenous knowledge systems; ✓ shows an appreciation of environmental sustainability.
5-6	Satisfactory	• *Only some* of the text is suitable for South African learners in diverse school contexts. • *Only some* of the text is presented in a manner that : ✓ demonstrates an appreciation of cultural and racial diversity; ✓ provides positive gender representation; ✓ shows an appreciation of indigenous knowledge systems; ✓ shows an appreciation of environmental sustainability.
1-4	Unsatisfactory	• The text is **not** suitable for South African learners in diverse school contexts. • The text does **not** represent an appreciation of diversity or provide positive gender representations

PART VI: DESIGN AND LAYOUT

Please provide a rating score based on the scale provided below and motivate your rating in the space provided. Cite specific page numbers, CAPS content/concepts/skills as well as textual references to substantiate the motivation. Use additional sheets as necessary.

DESIGN AND LAYOUT	RATING SCORE
The text is well designed and will be attractive and accessible for learners of this grade.	
Motivation:	

GUIDELINES FOR USING DESIGN AND LAYOUT RATING SCALE

DESIGN AND LAYOUT		
Score	**Descriptors**	**Key/Comment**
9-10	Excellent	• ***All*** of the text is designed in a way that makes it easy for learners to navigate the material. • ***All*** of the visuals/illustrations are easy to understand and clearly enhance the text. • ***All*** of the text is presented in a manner that : ✓ will be attractive and engaging for learners; ✓ will be accessible for learners; ✓ makes headings and captions clear; ✓ is easy to read with appropriately sized fonts and sufficient white space.
7-8	Good	• ***Most*** of the text is designed in a way that makes it easy for learners to navigate the material. • ***Most*** of the visuals/illustrations are easy to understand and clearly enhance the text. • ***Most*** of the text is presented in a manner that : ✓ will be attractive and engaging for learners; ✓ will be accessible for learners; ✓ makes headings and captions clear; is easy
5-6	Satisfactory	• ***Only some*** of the text is designed in a way that makes it easy for learners to navigate the material. • ***Only some*** of the visuals/illustrations are easy to understand and clearly enhance the text. • ***Only some*** of the text is presented in a manner that : ✓ will be attractive and engaging for learners; ✓ will be accessible for learners; ✓ makes headings and captions clear; is easy
1-4	Unsatisfactory	• The text is ***not*** easy for learners to navigate. • The visuals/illustrations are ***not*** clear or easy to understand. • The text is ***not*** attractive designed or accessible for learners of this grade level.

PART VII: TEACHER'S GUIDE

Please provide a rating score based on the scale provided below and motivate your rating in the space provided. Cite specific page numbers, CAPS content/concepts/skills as well as textual references to substantiate the motivation. Use additional sheets as necessary.

TEACHER'S GUIDE	RATING SCORE
The teacher's guide provides effective mediation of the subject content for the grade using language that ensures teachers can understand in diverse school contexts. It offers sufficient guidance in terms of planning, assessment, teaching methodology and gives useful examples.	
Motivation:	

CRITERIA: TEACHER GUIDE

Score	Description	Key/Comment
9-10	Excellent	• Provides **all the** guidelines and information that are relevant and appropriate to inform the subject content for the grade • All aspects (content, planning assessment, teaching methodology) pertaining to the subject have been mediated.
7-8	Good	• Provides **most of the** guidelines and information that are relevant and appropriate to inform the subject content for the grade • **Most** aspects (content, planning assessment, teaching methodology) pertaining to the subject have been mediated.
5-6	Satisfactory	• Provides **some of the** guidelines and information that are relevant and appropriate to inform the subject content for the grade • **Some** aspects (content, planning assessment, teaching methodology) pertaining to the subject have been mediated.
1-4	Unsatisfactory	• Provides **MINIMAL** guidelines and information that is relevant. • Guidelines are outdated and inappropriate for the subject. • Teacher Guide is not relevant for the grade. • Teacher Guide is not aligned and does not mediate the teaching resource.

SUMMARY SHEET

Title of Item Screened	
ISBN	
Average rating score:	
Recommendation	
Conditionally accept for National Catalogue Isolver and right acceptance?	
Do not accept for National Catalogue	
For conditional accepted titles: Examples of areas for improvement (please list below):	

This decision and the recommendation has been validated by Screening Team No _____

Screener Names and Signatures

Name: _____ Signature: _____

Name: _____ Signature: _____

Name: _____ Signature: _____

Name: _____ Signature: _____

Name: _____ Signature: _____

Team Leader: Date:

Signature: _____