

**AN EXPLORATION OF HOW TEACHERS PERCEIVE AND
RESPOND TO LANGUAGE DEMANDS ASSOCIATED WITH
THE LEARNING OF MATHEMATICAL LITERACY**

BY

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PHILOSOPHY**

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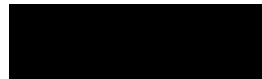
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ABSTRACT

With the introduction of Mathematical Literacy (ML) in schools in 2006, a renewed emphasis has been placed on the teaching of Mathematical knowledge and concepts with the use of real-life context-based education. The intention of ML is to provide learners with the opportunity to learn mathematics that is embedded in real-life context-based settings. Learners are expected to gain competencies such as to reason, make decisions, solve problems, manage resources and interpret information within a mathematical contextual setting. These competencies indicate that language skills have become an integral part of ML.

It was found that teachers believe that an understanding of the language of learning and teaching plays a pivotal role in learners' optimal performance in ML. The teachers implemented several strategies aimed at supporting learners with language demands associated with learning ML. The strategies included identifying key words in ML questions, reading the ML questions aloud, selecting resources carefully, providing support in interpreting the contextual setting before attempting to find the mathematical demand of the question, and using code switching in the classroom. Teachers also suggested ways in which they could be supported in the ML classroom.

The purpose of this study was to understand how teachers perceive and respond to the language demands associated with the learning of ML. To investigate how teachers perceive this phenomenon, a qualitative approach was adopted, and the analysis of data was conducted in three stages. First, questionnaires were distributed to 42 ML teachers to elicit their views about the role played by language in teaching and learning. Thirty-three teachers completed the questionnaires. The responses were analysed, and this analysis guided the second stage of the research which was the implementation of more meaningful classroom observations. Of these observed participants, all six agreed to participate further in the study by formulating thought provoking questions to gain more insights into how teachers perceive and respond to the language demands associated with the learning of ML.

The results of the study are limited in relation to generalisability because the sample was small. The findings indicate that teachers do consider the language proficiency of learners when they are teaching ML. The study found that a review of the existing channels of communication between stakeholders of the Department of Basic Education (DBE), and the ML teachers needs to be conducted, along with a review of the quality of the ML examination papers released by the DBE. Also, a research review needs to be conducted on how the DBE views the language demands associated with the learning of ML as reflected in the DBE policy documents on ML and, last, a

review on the effect the DBE resources have on teaching and learning in ML classrooms needs to be conducted.

KEY WORDS

Mathematical Literacy

Code switching

Contextual Setting

Mathematical Demand

Perception

Language Demands

Questioning

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LIST OF ABBREVIATIONS

BICS	Basic Interpersonal Communicative Skills
CALP	Cognitive Academic Language Proficiency
CAPS	Curriculum and Policy Statement
CTA	Common Tasks for Assessment test
DoE	Department of Education (South Africa)
DBE	Department of Basic Education (South Africa)
ERME	European Society for Research in Mathematics Education
FET	Further Education and Training
4QCCDF	Four-Quadrant Contextual and Cognitive Demands framework
ML	Mathematical Literacy
NSC	National Senior Certificate
SEN	Special Educational Needs

Table of contents

Chapter 1: Overview of the study	1
1.1 Introduction	1
1.2 Rationale of the study.....	3
1.3 Purpose of the study	4
1.4 Context of the study.....	4
1.5 Problem statement.....	5
1.6 Research objectives and questions	5
1.7 Methodological considerations	6
1.8 Conceptual framework.....	6
1.9 Possible contribution of this study	7
1.10 Organisation of the thesis.....	7
Chapter 2: Literature review.....	11
2.1 Introduction	11
2.2 An overview of Mathematical Literacy	11
2.3 An overview of Mathematical Literacy in South Africa	13
<i>2.3.1 The history of Mathematical Literacy in South Africa</i>	<i>13</i>
<i>2.3.2 South African perspective on and definition of Mathematical Literacy</i>	<i>15</i>
<i>2.3.3 The aims and goals of Mathematical Literacy.....</i>	<i>16</i>
<i>2.3.4 Progression regarding the Mathematical Literacy curriculum.....</i>	<i>18</i>
<i>2.3.5 The difference between Mathematics and Mathematical Literacy as Further Education and Training subjects</i>	<i>19</i>
2.4 Unpacking some of the language complexities related to the teaching and learning of Mathematical Literacy	20
<i>2.4.1 The relationship between language and mathematics performance in South Africa</i>	<i>21</i>
<i>2.4.2 The language complexities presented in Mathematical Literacy</i>	<i>22</i>
2.5 Challenges teachers face in supporting learners with Mathematical Literacy questions and how they support learners in the Mathematical Literacy classroom.	28
<i>2.5.1 Factors to consider that present as a barrier to learners' optimal performance in answering Mathematical Literacy questions</i>	<i>31</i>
<i>2.5.2 Language factors that influence learning in the Mathematical Literacy classroom.</i>	<i>37</i>
<i>2.5.3 Teachers reading questions aloud to support learners in Mathematical Literacy</i>	<i>40</i>
2.6 Problems in identifying mathematical demand and linking it to the contextual setting. 41	
<i>2.6.1 Use of code switching</i>	<i>42</i>

2.6.2 Code switching in the Mathematical Literacy classroom.....	43
2.6.3 The use of code switching to support the understanding of the contextual setting of Mathematical Literacy questions.....	44
2.7 Support provided by the Department of Basic Education to Mathematical Literacy teachers.....	47
2.8 Conclusion.....	48
Chapter 3: A conceptual framework for the description of CALPs in ML	49
3.1 Introduction	49
3.2 Components of language proficiency	49
3.3 ML tasks	50
3.4 Acquiring CALP in ML	52
3.5 The Cummins Model of language acquisition.....	54
3.5.1 The Four Quadrants model	55
3.6 Conclusion.....	56
Chapter 4: Data collection process.....	57
4.1 Introduction	57
4.2 Research questions	57
4.3 Research methodology	58
4.3.1 Research paradigm.....	58
4.3.2 Research method.....	59
4.3.3 Research design.....	61
4.3.4 Research approach	62
4.4 Sampling of participants	63
4.5 Data collection.....	64
4.5.1 Categorisation of participants.....	64
4.5.2 Data collection strategies	65
4.6 Data collection procedure	72
4.6.1 Reasons for selection of the instruments.....	72
4.6.2 Questionnaires.....	72
4.6.3 Observations.....	73
4.6.4 In-depth interviews	73
4.7 Validity and credibility of research instruments	73
4.7.1 Validity.....	73
4.7.2 Credibility.....	74
4.8 Ethical considerations	75

4.8.1 Ethical Expectations	75
4.8.2 Informed Consent	75
4.8.3 Conflict of Interest	76
4.9 Development of the research questions.....	77
4.10 Data analysis and feedback to participants.....	77
4.10.1 Analysing qualitative data	77
4.10.2 Feedback to respondents	78
4.10.3 Analysis of the data using the Cummins Framework	78
4.11 Storage of data and disposal of data	80
4.12 Conclusion	80
Chapter 5: Questionnaire	81
5.1 Introduction	81
5.1.1 Categorisation of participants	81
5.2 Teacher information.....	82
5.2.1 Gender	82
5.2.2 Years of teaching experience	83
5.2.3 Teacher's qualifications	83
5.3 English proficiency and Mathematical Literacy.....	84
5.3.1 The home language of learners	84
5.3.2 Disadvantages in not being able to speak English as a first language	86
5.4 Teachers' language used in the classroom.....	90
5.5 Conclusion.....	93
Chapter 6: The Mentor	94
6.1 Introduction	94
6.2 Background of the participant and his teaching environment	94
6.3 The lesson transcript	95
6.3.1 Lesson observation	96
6.4 Views of Mathematical Literacy and the curriculum.....	108
6.5 English and its relationship with Mathematical Literacy.....	112
6.6 Jan's mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework.....	116
6.7 Conclusion.....	119
Chapter 7: The Code Switcher	120
7.1. Introduction	120
7.2 Background of the participant and her teaching environment	120

7.3 The lesson transcript	122
7.3.1 Lesson observation	123
7.4 Views of Mathematical Literacy and the curriculum.....	132
7.5 English and its relationship with Mathematical Literacy	134
7.6 Nothando's mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework	135
7.7 Conclusion	138
Chapter 8: The Leader	140
8.1 Introduction	140
8.2 Background of the participant and her teaching environment	140
8.3 The lesson transcript	141
8.3.1 Lesson observation	142
8.4 Views of Mathematical Literacy and the curriculum.....	151
8.5 English and its relationship with Mathematical Literacy	155
8.6 Sarah's mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework	157
8.7 Conclusion	159
Chapter 9: The Kind One	161
9.1 Introduction	161
9.2 Background of the participant and her teaching environment	161
9.3 The lesson transcript	162
9.3.1 Lesson observation	163
9.4 Views of Mathematical Literacy and the curriculum.....	178
9.5 English and its relationship with Mathematical Literacy	180
9.6 Bridgette's mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework	182
9.7 Conclusion	184
Chapter 10: The Organiser	186
10.1 Introduction	186
10.2 Background of the participant and his teaching environment	186
10.3 The lesson transcript	188
10.3.1 Lesson observation	188
10.4 Views of Mathematical Literacy and the curriculum.....	203
10.5 English and its relationship with Mathematical Literacy	205
10.6 Njabulo's mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework	208

10.7 Conclusion	210
Chapter 11: The Rising Star	211
11.1 Introduction	211
11.2 Background of the participant and her teaching environment	211
11.3 The observation notes.....	212
11.4 Views of Mathematical Literacy and the curriculum.....	219
11.5 English and its relationship with Mathematical Literacy	222
11.6 Sindisiwe's mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework	223
11.7 Conclusion	225
Chapter 12: Research findings, conclusion, and recommendations	226
12.1 Introduction	226
12.2 Description of participants.....	226
12.3 Research question one	227
12.3.1 Teachers believe that to do well in Mathematical Literacy, learners need to be proficient in English.	227
12.3.2 There are various language complexities that all Mathematical Literacy learners have to navigate	228
12.3.3 Mathematical Literacy learners for whom English is a second language experience additional difficulties in dealing with the language complexities in Mathematical Literacy..	229
12.3.4 When the contextual setting is not familiar to the learners, it places additional demands on them	230
12.3.5 The complex language used in examination tasks increases their difficulty	231
12.3.6 Teachers feel that learners experience problems in identifying mathematical demand and linking this to the contextual setting.	232
12.4 Research question two.....	233
12.4.1 The teachers helped learners identify key words needed to understand the question. .	233
12.4.2 Reading Mathematical Literacy questions aloud to support learners.....	235
12.4.3 Resources are carefully selected or designed by teachers to support learners in Mathematical Literacy examinations	236
12.4.4 The teachers' personal dispositions conveyed empathy towards the learners as they tried to support them in dealing with the language complexities in Mathematical Literacy...	237
12.4.5 Participants' strategies in linking the contextual setting to find the mathematical demand of the question	238
12.4.6 Code switching to support the understanding of the contextual setting to find the mathematical demand of the question	240
12.4.7 Findings derived from the 4QCCDF	242

Figure 12.1.....	242
<i>Cummins’s (1994) Four-Quadrant Contextual and Cognitive Demands Model (p. 41, adapted).</i>	242
12.5 Research question three	250
12.5.1 <i>The Department of Basic Education must ensure greater alignment between textbook and examinations.</i>	250
12.5.2 <i>The Department of Basic Education must create channels of communication between and among teachers, Department of Basic Education, and examiners.</i>	251
12.6 Reflection.....	251
12.7 Recommendations and opportunities for further research	251
12.8 Limitations of the study	252
12.9 Contribution of this study	253
12.10 Final reflection	253
12.11 Conclusion	253
References	254
Appendices	280

List of figures

Figure 2.1 Timeline of curriculum change for the subject ML.....	14
Figure 2.2 ML in practice	33
Figure 3.1 Cummins’s (1994) Four-Quadrant Contextual and Cognitive Demands Framework (p. 41, adapted)	56
Figure 4.1 Criteria used to classify tasks in the 4QCCDF model	79
Figure 6.1 Extract from the NSC Grade 12 June 2022 Examination paper 1, Question 3	97
Figure 6.2 Extract of the NSC Grade 12 June 2022 Examination paper one Question 3.1.1.	98
Figure 6.3 Extract from the NSC Grade 12 June 2022 Examination paper 1, Question 3.1.2	98
Figure 6.4 Extract of the NSC Grade 12 June 2022 Examination paper 1, Question 3.1.3.....	104
Figure 6.5 Extract of the NSC Grade 12 June 2022 Examination paper 1, Question 3.2.....	104
Figure 6.6 Extract of the NSC Grade 12 June 2022 Examination paper one Question 3.2.1	104
Figure 6.7 Extract of the NSC Grade 12 June 2022 Examination paper one Question 3.2.2	105
Figure 6.8 Extract of the NSC Grade 12 June 2022 Examination paper 1, Question 3.2. Annexure B	106
Figure 6.9 Extract from the NSC Grade 12 June 2022 Examination paper 1, Question 3.2.3 .	106108
Figure 6.10 Extract of the NSC Grade 12 June 2022 Examination paper 1, Question 3.2.4.....	110
Figure 6.11 Extract from the completed Questionnaire that Jan submitted.....	110
Figure 6.12 Extract of the NSC Grade 12 June 2022 Examination paper 1, Question 4.1.3.....	115
Figure 6.13 Extract of the NSC Grade 12 June 2022 Examination paper 1, Question 4. Answer sheet	115
Figure 7.1 Displays how the roof is constructed in a block of three classrooms and how this creates a challenging teaching and learning environment	121
Figure 7.2 Displays how the roof is constructed in a block of three classrooms and how this creates a challenging teaching and learning environment	121
Figure 7.3 Extract from the completed Questionnaire Nothando submitted in relation to her view of her own English proficiency	121
Figure 7.4 Displays further evidence of a key word on the board during the observed lesson	124
Figure 7.5 Shows a question used during the observed lesson	125
Figure 7.6 Displays evidence of the method used by Nothando to complete a percentage calculation	126
Figure 7.7 Displays evidence of the method used by Nothando to display the ratio required for Question 1.1.4.....	127
Figure 7.8 Displays evidence of the method used by Nothando to display the simplified ratio required for Question 1.1.4.....	127
Figure 7.9 Displays the evidence of how Nothando illustrated the calculation of the mean for Question 3.1.4.....	131
Figure 7.10 Extract of the completed questionnaire Nothando submitted in relation to her opinions about ML	133
Figure 8.1 Extract of the completed questionnaire Sarah submitted about her own English proficiency	141
Figure 8.2 Question used in the observed lesson.....	143
Figure 8.3 Extract from Question 2.1	144
Figure 8.4 Extract from Question 2.2	146
Figure 8.5 Evidence of the method used by Sarah to covert from cups to litres	147

Figure 8.6 Extract from Question 2.3	148
Figure 8.7 Evidence of the method used by Sarah to conduct a time calculation	150
Figure 8.8 Extract from the completed questionnaire Sarah submitted about her opinions about ML	152
Figure 9.1 Extract from the completed questionnaire Bridgette submitted on her thoughts about teaching the mathematics content before teaching the real-life context	162
Figure 9.2 Question from the textbook that was used in one observed lesson	163
Figure 9.3 Evidence of the method used by Bridgette to calculate the radius	165
Figure 9.4 Question from the textbook that was used in the observed lesson	167
Figure 9.5 Question from the textbook that was used in the observed lesson	168
Figure 9.6 Question from the textbook that was used in the observed lesson	170
Figure 9.7 Evidence of the method used by Bridgette to calculate the volume of a cylinder.....	171
Figure 9.8 Evidence of the method used by Bridgette to calculate the volume of two cylinders...	173
Figure 9.9 Question from the textbook that was used in the observed lesson	174
Figure 9.10 Extract from the completed questionnaire Bridgette submitted in relation to her opinions about ML.....	179
Figure 10.1 Extract from the completed questionnaire Njabulo submitted in relation to his thoughts about his own English proficiency	187
Figure 10.2 Displays the initial steps taken in drawing a bar graph showing the percentage of pupils passing mathematics in each grade from 8 to 12 in 2021	189
Figure 10.3 Displays the complete drawing of a bar graph showing the percentage of pupils passing mathematics in each grade for 2021	190
Figure 10.4 Displays the completed drawing of a single bar graph showing the percentage of pupils passing mathematics in each grade for 2021 next to an initial drawing of a double bar graph showing the percentage of pupils passing mathematics in each grade for 2021 and 2022.....	192
Figure 10.5 Displays the complete drawing of a bar graph of Farmer Frank’s total sales of vegetables for day 1	193
Figure 10.6 Displays the initial drawing of a double bar graph showing Farmer Frank’s total sales of vegetables for day 1 and day 2	196
Figure 10.7 Displays the complete drawing of a double bar graph showing Farmer Frank’s total sales of vegetables for day 1 and day 2	197
Figure 10.8 Reflects a question used in the observed lesson	198
Figure 10.9 Displays the data required for question 3.3	199
Figure 10.10 Displays median calculations on the board	202
Figure 10.11 Reflects a question used in the observed lesson	202
Figure 10.12 Extract from the completed questionnaire Njabulo submitted in relation to his opinions about ML.....	204
Figure 10.13 Questions used in the observed lesson that need learners to understand what “difference” means in mathematical language	207
Figure 11.1 Extract from the completed questionnaire Sindisiwe submitted in relation to her thoughts about her own English proficiency	212
Figure 11.2 Sindisiwe placed a copy of the worksheet on the board given the limited resources available to her.....	213
Figure 11.3 Sindisiwe asked question 2.1 during the observed lesson from National Senior Certificate Grade 10 past examination papers	214
Figure 11.4 Question 2.1.1	214

Figure 11.5 Evidence of the answers Sarah supplied the learners in the class	215
Figure 11.6 Below is Question 2.1.2	216
Figure 11.7 Question 2.1.3.....	216
Figure 11.8 Evidence of a conversion table used by Sindisiwe to convert units in measuring	216
Figure 11.9 Question 2.1.5	217
Figure 11.10 A question used during an observed lesson.....	218
Figure 11.11 Extract from the completed questionnaire Sindisiwe submitted regarding her opinions about ML	220
Figure 12.1 Cummins's (1994) Four-Quadrant Contextual and Cognitive Demands Model (p. 41, adapted).....	242
Figure 12.2 4QCCDF illustrating Jan's movement between quadrants.....	244
Figure 12.3 4QCCDF illustrating Sarah's movement between quadrants	245
Figure 12.4 4QCCDF illustrating Bridgette's movement between quadrants	247
Figure 12.5 4QCCDF illustrating Nothando's movement between quadrants	247
Figure 12.6 4QCCDF illustrating Njabulo's movement between quadrants	248
Figure 12.7 4QCCDF illustrating Sindisiwe's movement between quadrants	249

List of Tables

Table 2.1 Definition of ML.....	12
Table 2.2 Comparison of the definitions of ML and Mathematics	19
Table 2.3 Didactic practices relating to mathematics teaching in a ML classroom.....	30
Table 3.1 Structure of contextual tasks	51
Table 4.1 Observation schedule.....	68
Table 4.2 Definition of strategies to ensure trustworthiness in qualitative research.....	74
Table 5.1 Question: The home language of the majority of the learners in my school is English....	85
Table 5.2 Question: Learners who do not speak English as a first language are disadvantaged in a ML classroom.....	88
Table 5.3 Question: Learners who do not speak English as a first language struggle to answer test and examination questions because of the lack of English language skills.....	89
Table 5.4 Question: A teacher needs to be very proficient in English for effective teaching of ML	90
Table 5.5 Question: Which language do you use when you teach your Mathematical Literacy classes?9292	
Table 5.6 Question: Do you think that learners struggle to understand you in the classroom when you use English as a medium of instruction?	93
Table 12.1 A short description is used to describe the participants that were observed and interviewed for this research study	226

List of Graph

Graph 5.1 Total number of schools represented in this study	81
Graph 5.2 Total number of participants categorised for this study	82
Graph 5.3 Participants' Qualifications	84
Graph 5.4 The home language of the majority of the learners in my school is English	85
Graph 5.5 Learners who do not speak English as a first language are disadvantaged in a ML classroom	87
Graph 5.6 Learners who do not speak English as a first language struggle to answer test and examination questions because of the lack of English language skills	89

Chapter 1: Overview of the study

1.1 Introduction

The official language policy in formal education in South Africa has a troubled history, particularly regarding the Language of Learning and Teaching in African schools. This policy has been connected to the politics of domination and separation, resistance, and affirmation according to the African National Congress (1994). Lafon (2009) noted that while all languages are described as equal, some languages, namely English (and Afrikaans) are more equal than others and have more prominence. In spite of the lofty principles spelled out in the Constitution, support for the use of African languages as Languages of Learning and Teaching remains limited as Makananise and Madima (2020) have indicated, and this means that only English and Afrikaans speakers are advantaged. Although the majority of South Africans are Black and speak African languages at home, English has become a status symbol for education, affluence, internationalism, and freedom in South Africa (Posel et al. 2020). Prinsloo and Harvey (2020) indicated that many South Africans continue to be educated either partially or entirely in a second or third language and that this effectively limits their educational opportunities, particularly in relation to higher education because at this level English literacy requirements are at a much higher standard than at secondary level. This raises challenges given its impact on throughput rates (Ndebele et al. 2013), attitudes (Nkosi, 2014), classroom interaction (Madiba, 2014; Makalela, 2015) and policy implementation (Turner & Wildsmith-Cromarty, 2014). This emphasises the importance of research into the languages of education if we are to inform and implement language policy and practice that will promote learning and social justice for all.

Cummins et al. (2012) observed that learner and teacher proficiency in the medium of instruction largely determines academic success. Manyike and Lemmer (2014) supported this statement by adding that a major obstacle to equity of education in South Africa is the continuing failure to meet the needs of learners who speak African languages and who are learning English as an additional language and using it as the medium of instruction in other learning areas. African language speaking learners in South Africa annually demonstrate underachievement in school-leaving examinations (Postma & Postma, 2011). Poor annual national literacy and numeracy performance (Department of Basic Education, 2012) including in international benchmarking assessments, Martin et al. (2007), in their report, Progress in international reading literacy study, 2006, is

indicative of language related difficulties. These findings emphasise the importance of language proficiency in ML.

Globally, there has been much attention paid to how school learners could be better prepared to participate in the 21st century. There is also a growing awareness of the importance of mathematical literacy (ML) for personal empowerment and for becoming a critical citizen (Gal, 2023). Many countries have engaged in curriculum revisions to better prepare learners to become critical thinkers who can contribute to solutions to complex problems. In South Africa, ML was introduced as a separate subject, different in scope and purpose from the symbolic and formal school subject of mathematics but ML consists of more than just mathematics. With the introduction of ML in schools in 2006, a renewed emphasis was placed on the teaching of mathematical knowledge and concepts in relation to real-life context-based education (Department of Basic Education, 2011b)¹. Within this teaching approach, pure mathematical calculations that emphasise the importance of using mathematical formulae and concrete thinking, are gradually becoming less emphasised. The Department of Basic Education (2011b) defined ML as follows:

Mathematical literacy provides learners with an awareness and understanding of the role that Mathematics plays in the modern world. Mathematical Literacy is a subject driven by life-related applications of Mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday solutions and to solve problems. (p. 9)

The methods that relate to teaching pure mathematical knowledge and concepts are not stressed emphatically in the current ML syllabus. The inclusion of comprehension scenarios and questions of a high linguistic level that emphasise only minimally the development of concrete computational skills places demands on learners in terms of their language skills. The incorporation of comprehension questions in the ML curriculum highlights the importance of developing English reading and comprehension skills, or put differently, English proficiency, in the teaching of ML. Bansilal and Wallace (2008) noted that a consequence of weak language skills was that learners struggled to cope with questions in text written at a high level of complexity. Hence the integration of English reading and comprehension skills with the teaching of mathematical concepts formed a new paradigm of thinking for both teachers and learners.

¹ The Department of Education is referenced as such since this is how it was referred to up until 2009. After this the School Educational sector was placed under the Department of Basic Education and it is then referenced as such.

ML as a subject requires more than just competencies from learners in mathematical computations. Competencies that learners hope to gain by selecting ML as a subject choice include the ability to reason, make decisions, solve problems, manage resources, interpret information, schedule events, and use and apply technology (Department of Basic Education, 2011b). Elements such as reasoning, decision making, interpreting information, and solving problems indicate that language has become an integral part of ML. Therefore, effective teaching of ML emphasises that learners should acquire a high level of English proficiency to tackle ML tasks and problems successfully. Rather than performing calculation-oriented questions in a pure mathematical-based task, learners are now expected to extract mathematical content from literacy-based questions and/or tasks. Robertson and Graven (2019) stated that since language is the main medium through which mathematics teaching and learning takes place, acquiring the requisite linguistic proficiency for meaningful participation in mathematical discussion needs to become an explicit learning goal in the mathematics classroom. Thus, ML as a subject presents a challenge to teaching and learning in the classroom since teaching and learning mathematical arithmetic is not the only component learners have to master to succeed at ML.

ML thus presents many barriers to learning in the classroom, one of which, as identified by Bansilal and Wallace (2008) is that learners struggle to make sense of questions that require a greater level of interpretation than that to which they are accustomed because of their weak language skills. This led to learners experiencing a sense of information overload, and this, in turn, hinders their performance in ML.

1.2 Rationale of the study

Mathematics education begins in language. However, as Barwell (2020) noted, language in mathematics is a very contentious topic that is rarely appreciated. In my ten years of experience in teaching mathematics in the General Education and Training (GET) band in South Africa and as a ML teacher in Grades 10 to 12, and my six years of experience in teaching Year 7 to 11 in the General Certificate of Secondary Education sector (GCSE) in the United Kingdom, I have observed that mathematical proficiency in number skills for learners in secondary schools is crucial to improved performance in mathematical tasks and related computational procedures in ML. In addition, I have observed that a number of low achieving English language learners who have good mathematical skills perform at a lower level when they face a problem that incorporates a real-life context, rather than having it posed in a conventionally pure mathematical context. This proves problematic in that the low achieving English subject learners find ML very challenging given this

need for an increased level of comprehension, so language becomes a determining factor in ML assessments for these learners.

Maluleka (2019) indicated that learners tend to perform better in ML if they are proficient in English. So language proficiency can be seen to play a part in the level of performance of learners in ML. Research has established across many contexts that English first language speakers outperform English second language speakers on mathematics assessments (Prediger, 2019). I conducted a research study for my Masters in Inclusive Education at UNISA. This qualitative study directed me towards how teachers perceive and respond to language demands associated with the learning of ML. I believe that approaching this phenomenon from a teacher's perspective would provide valuable information. Teachers are, after all, the people who observe learners in their learning environment so this would be a more holistic and complete approach to use to determine the language demands associated with the learning of ML.

1.3 Purpose of the study

The purpose of this study is to focus on how teachers perceive and respond to language demands associated with the learning of ML. Quality mathematics teaching in South Africa will remain out of reach unless teachers make efforts to understand how their learners think and learn and recognize their learning experiences (Moloi, 2012). In this research study I discuss how teachers' intentions and actions may be driven by their perception of the kind of support needed by learners in the ML classroom.

1.4 Context of the study

In South Africa, only two of the country's eleven official languages—English and Afrikaans—are used in the Grade 12 exit examinations. According to Statistics South Africa (2018, p. 20) the general household survey of the population in South Africa indicated that 12.2% of the population spoke Afrikaans and 8.1% spoke English at home. This leaves us with 79.7% of the South African population who do not speak the language of examination at home. This is a significant number and necessitates an investigation into how this vast majority of learners in South Africa are viewed by their teachers in relation to how the latter perceive and respond to language demands associated with the learning of ML.

1.5 Problem statement

The Department of Education's system that embraces English and Afrikaans as the languages of teaching and learning in South Africa presents several challenges in most of the classrooms in this country. The main challenge is teaching ML in English to second language speakers of English. The Association of Mathematics Educators in South Africa (AMESA) has pointed out that if literacy is the ability to read and write, then ML should be the ability to read, write and engage with information and situations that are numerical in nature and mathematical in structure. (2003, p. 2)

The learners in a ML classroom face the challenge of being expected to perform many operations, linguistically and mathematically. Graven and Venkat (2007) stated that applications of mathematics to word problems that link to the real world in various ways are provided in the hope that they will support "logical reasoning about problems in the physical and social world" (p. 7) In order for this ideal to be realised, learners must be able to understand what they are reading if they are to use such logical reasoning about problems that they, and others, face in the physical world. It is vital that teachers have the ability to do this themselves in order to impart the knowledge learners need if they are to learn in the correct way. In a study conducted by Mkhwanazi and Bansilal (2014), it emerged that the contextual language posed a barrier to many teachers. In not being able to decode contextual language, they could not access the specific information that would determine the mathematical demands in ML questions. This raises the question of the relationship between the learners' inability to cope with the demands of ML and the teachers' inadequacy given their lack of proficiency in English. In this research study, I seek to establish how teachers perceive and respond to language demands associated with the learning of ML and to determine how prolific these demands are.

1.6 Research objectives and questions

The main aim of this research study was to determine teachers' perceptions of, and responses to, the language demands associated with the learning of ML.

The objectives of this study were:

- i) to understand teachers' perceptions of the learners' struggles with language complexity in ML.
- ii) to explore how teachers support the learners in addressing the language demands and complexity in ML.
- iii) to obtain teachers' suggestions on how they could be more effectively supported in teaching ML.

Accordingly, in this thesis, I sought to address the following questions:

1. What are teachers' perceptions of the learners' struggles with the language complexity in ML?
2. How do teachers support the learners in addressing the language demands and complexity in ML?
3. What are teachers' suggestions on how they could be more effectively supported in teaching ML?

1.7 Methodological considerations

This study involved conducting research to establish the perspectives of the teachers on how they perceive and respond to the language demands associated with the learning of ML. Following McMillan and Schumacher (2010), the research questions were posed using a qualitative research approach aimed, in general, at understanding a social situation from the participants' perspective. I selected thematic analysis as the design for this research study since Braun and Clarke (2022) established that thematic analysis may be used to identify, analyse, organise, describe, and report themes found within a data set. I located the selected research paradigm for this study in a constructivist paradigm. Kivunja and Kuyini (2017, p. 33) observed that a constructivist approach attempts to "get into the head of the subjects being studied" in order to gain an understanding of what the participant is thinking in a specific context.

The data for this research study was obtained in three stages. During the first stage I collected data from thirty three participants who responded to a questionnaire. Then I conducted participant lesson observations, and I interviewed six participants.

1.8 Conceptual framework

For this research study, I drew on Cummins's (1979, 1984, 2008) language proficiency framework to gain a deeper understanding of the role language plays in teaching and learning ML and the ways in which ML teachers take account of these language demands in their teaching. I used Cummins's (1994) Four-Quadrant Contextual and Cognitive Demands framework (4QCCDF) (see Figure 3.1) to categorise data on a cognitively demanding or cognitively undemanding, and context embedded or context reduced scale while I measured the language used in the classroom in terms of basic interpersonal communicative skills (BICS) language or cognitive academic language proficiency (CALP) language. I placed participants on the graph according to their approach to teaching ML and

how they responded to the language demands associated with the learning of ML in their classrooms (see Figure 12.2 to 12.7).

1.9 Possible contribution of this study

Research has been conducted in South Africa about the role and influence language plays in an ML classroom. However, most research has been conducted from the perspective of the learners in the classroom, so an opportunity to determine the perspective of the teachers in relation to language demands associated with the learning of ML in their classrooms presented itself to me. Bansilal (2014a) stated that no other country has developed a subject such as ML that necessitates such an exclusive focus. She recommended that further research be conducted and that teachers be encouraged to give feedback on, and insight into, the current understanding of how they could help fulfil the mandate of ML. This research study is intended to inform policy makers about the challenges faced by teachers in ML classrooms that are not supported by any content in policy documents. In this study, I provide valuable feedback from teachers about the challenges they face when they are teaching ML, and how they overcome these challenges. The purpose of the study is to emphasise that teaching ML is not just about teaching mathematics; there are several other challenges that teachers face in teaching this subject.

The title of this research study was driven by the lack of research conducted in its academic sphere. Matope & Chiphambo (2022) and Graven & Robertson (2020) recommended further research in the use of code switching to improve learners' understanding in the ML classroom. Further to this, Hoogland et al. (2016) recommended that further research be conducted on the improvement of the connection between the mathematical demand and the contextual setting in ML problems. Personally, this research study has contributed to my own professional development and has given me more insight into developing policies on mathematics in an international setting and has assisted me in finding solutions to this issue in South Africa.

1.10 Organisation of the thesis

Chapter 1: Introduction

The factors pertaining to the contextual background factors, problem statement, rationale, purpose of the study, and its aims and objectives, are discussed. The research questions are delineated along with the rationale behind, and significance of, this research study.

Chapter 2: Review of the literature

In this chapter I establish a correlation between previous literature and the objectives of this research. I use the existing literature to provide context to the research study. I accentuate the value of the research study through the review of existing literature. I present an overview of ML including its implementation and intention in South Africa. I explore the relationship between a learner's English proficiency and ML performance by elaborating on the language complexities, language used in the classroom, the language of mathematics, and the use of code switching in ML classrooms. I identify the factors that teachers consider to be a barrier to learning in ML classrooms through existing research by focusing on the challenges teachers face in supporting learners in ML classrooms and the factors that teachers see as presenting a barrier to learners performing optimally in answering ML questions. Then I explore the correlation between the identification of mathematical demand and a ML question's contextual setting. I address the problems learners have in identifying the mathematical demands and linking them to the contextual setting. I consider strategies such as code switching to support learners in understanding the contextual setting and the mathematical demand of ML questions.

Chapter 3: Conceptual framework

Here I discuss in detail the reasoning behind my selecting a qualitative research approach. I discuss the relationship between the conceptual framework and my selection of the research design. I use the Cummins four quadrant model of language acquisition to allocate data for this research study.

Chapter 4: Research methodology

In this chapter I describe my research methodology. I refer to the ethical issues involved and elaborate on the selection of participants. I describe the data collection strategies and the procedures I followed. I motivate for the validity and credibility of the data collection instruments. This follows the development and refinement of the research questions through the analysis and feedback of data to the participants. I then describe the procedure of storage and disposal of data.

Chapter 5: Questionnaire findings

Here I analyse, scrutinize, and display for evaluation purposes the findings from the questionnaires that identify the participants' information such as gender, years of teaching experience and qualifications obtained. I explore participants perception of their own English proficiency and the influence English proficiency has on learners' ML performance.

Chapter 6: The Mentor

The following six chapters elaborate on the data collected from six participants who were observed teaching their learners and who then participated in an in-depth interview. The first participant was Jan, a male teacher in his mid-thirties with 12 years' teaching experience. He teaches ML and Core Mathematics in a well-resourced school. He is a second language English speaker with Afrikaans being his home language and does not use code switching in his classroom. Jan was named the Mentor since he is a rugby coach, a hostel boarder master, and a ML teacher who was concerned about learners with different social backgrounds settling into the school.

Chapter 7: The Code Switcher

The second participant was Nothando, a female teacher in her mid-thirties with 14 years' teaching experience teaching ML in an under-resourced school. Nothando is a second language English speaker with isiZulu being her home language and she was observed using code switching in her classroom. I named her the Code Switcher since she was the participant who used code switching most frequently.

Chapter 8: The Leader

The third participant was Sarah, a female teacher in her mid to late forties with 25 years' experience teaching ML in a well-resourced school. Sarah is a second language English speaker with Sotho being her home language and she was observed using code switching in her classroom. Sarah was named the Leader because she is the Senior Deputy headmistress at her school.

Chapter 9: The Kind One

The fourth participant was Bridgette, a female teacher in her late thirties with 10 years' experience of teaching ML in a well-resourced Special Educational Needs (SEN) school. Bridgette is a first language English speaker who does not use code switching in her classroom. Bridgette was named the Kind One for teaching SEN learners in a very understanding, kind, and supportive manner. Since Bridgette teaches in a SEN school, she approaches her learners in a softly spoken manner and always attempts to support them in their academic and physical needs.

Chapter 10: The Organiser

The fifth participant was Njabulo, a male teacher in his mid-thirties with 13 years' teaching experience in ML and Core Mathematics in an under-resourced school. Njabulo is a second language English speaker who was observed using code switching in his classroom. Njabulo was named the Organiser since he is the Head of the Department of Mathematics at his school and because he arranged to have me observe his colleague Nothando, as well.

Chapter 11: The Rising Star

The sixth and last participant was Sindisiwe, a female teacher in her mid-twenties with one year of experience teaching ML in an under-resourced school. Sindisiwe is a second language English speaker who was observed using code switching in her classroom. Sindisiwe was named the Rising Star because she was the least experienced and youngest participant who was observed and interviewed for this research study. She was named the Rising Star also because she is very enthusiastic about teaching ML.

Chapter 12: Research findings, conclusion, and recommendations

I discuss my research findings and explore them using the data I obtained from the questionnaires, lesson observations, and in-depth interviews. I offer a summary of the experience of the research study, my findings, conclusions, the limitations of my study, and recommendations for further research in this chapter.

Appendices

All additional information for the research study is offered in this section.

Chapter 2: Literature review

2.1 Introduction

In this chapter, I describe and evaluate the literature that informs this research study. I introduce an overview of ML and what it constitutes its implementation in South Africa. Further I describe how ML has progressed in South Africa as a subject and what differences there are between ML and Core Mathematics. I then elaborate on the relationship between learners' English proficiency and their optimal performance in ML and consider the challenges that teachers face in supporting learners to deal with ML questions. I then explore problems in identifying mathematical demand and link this to the contextual setting and consider the role that the DBE has played in ML. Some repetition in this chapter is inevitable given the volume of scholarly work to date on various aspects of the relationship between language acquisition and learning.

2.2 An overview of Mathematical Literacy

A continuous evolution in mathematics supports the development of ML. Diaz (2017) stated that ML is based on a vision of inscribing a mathematical model of a world that was taught to create a better kind of person and, in turn, produce a more effective person in the workplace. This new vision led to the development of ML and this definition by the Organisation for Economic Co-operation and Development (2009):

ML is concerned with the ability of learners to analyse, reason, and communicate ideas effectively as they pose, formulate, solve, and interpret solutions to mathematical problems in a variety of situations. (p. 14)

This definition addresses the capacity of learners to extract what they have learnt using literacy as a skill, and to apply this knowledge in various situations. This definition also focuses on the learners' capacity to analyse, reason, and communicate effectively as they pose, solve, and interpret problems in a variety of situations. The Organisation for Economic Co-operation and Development (2009) definition of ML extends into defining the content, processes, and situations as displayed in the table that follows.

Table 2.1

Definition of ML (The Organisation for Economic Co-operation and Development, 2009, pp. 14–15).

Content	This is defined mainly in terms of four overarching ideas (quantity, space and shape, change and relationships, and uncertainty) and only secondarily in relation to curricular strands (such as numbers, algebra, and geometry).
Processes	These are defined by individual mathematical competencies and include the use of mathematical language, modelling, and problem-solving skills. Such skills, however, are not separated out in different test items since it is assumed that a range of competencies will be needed to perform any given mathematical task. Rather, questions are organized in terms of competency clusters that define the type of thinking skill needed.
Situations	These are defined in terms of the ones in which mathematics is used, based on their distance from the learners. The framework identifies five situations: personal, educational, occupational, public and scientific.

The Programme for International Learner Assessment framework (The Organisation for Economic Co-operation and Development, 2013) defines ML as

an individual's capacity to identify and understand the role that Mathematics plays in the world, to make well-founded judgements and to use and engage with Mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. (p. 7)

This definition focuses purely on the mathematical understanding of the world and on creating a citizen who can use mathematics to meet his or her needs in life. This is expressed in terms such as “well-founded judgements”, “meet the needs of the individual”, and becoming a “concerned and reflective citizen.” The objective of ML as stated by Diaz (2017) is to create a mathematically literate person who is confident, in control, and who could make reasonable choices now and in the future. This definition corresponds with the intended outcomes for a South African learner and is embodied in the ethos of ML as a Further Education and Training (FET) subject in South Africa as detailed in the section that follows.

2.3 An overview of Mathematical Literacy in South Africa

An overview of ML is discussed to provide a context and intention for the implementation of ML in South Africa.

2.3.1 The history of Mathematical Literacy in South Africa

Before the introduction of ML in 2006, there was only one mathematically based subject called mathematics. This subject was compulsory for all learners up to the completion of Grade 9. Mathematics became an optional subject choice in Grades 10 to 12. The choices learners had were to do mathematics at either a Higher or a Standard grade level. Both were scientifically rooted in principles. The difficulty in the assessment of scientifically based mathematics was, however, differentiated between the two subject choices. Venkatakrishan and Graven (2006) noted that there was minimal success with this subject selection prior to 2006, and that just over 40% of learners chose at the end of Grade 9 not to select mathematics in Grades 10 to 12. Of the just fewer than 60% of learners who selected mathematics as a subject after Grade 9, approximately 50% selected Standard Grade Mathematics and fewer than 9% of the learners selected Higher Grade mathematics (Venkatakrishan and Graven, 2006). Prior to 2006, learners left school after the Grade 9 examinations with only a scientific based mathematical knowledge; the 40% of learners who completed their schooling after successfully passing their examinations in Grade 12 and did not select mathematics (either at Standard Grade or Higher Grade), resulted in a large percentage of adults with a minimal amount of mathematical knowledge. To resolve this issue of mathematical inequality, an attempt to rectify the situation resulted in the selection of mathematics in the FET phase becoming compulsory for all learners in South Africa. Instead of having a choice of two scientific-based mathematics subjects, the DBE gave learners a selection of two subjects—ML and Core Mathematics. Core Mathematics is very similar to Standard Grade or Higher Grade Mathematics prior to 2006. ML moved away from the scientific-based mathematics offered prior to 2006 and offered a more practical and real-life paradigm to support learners in general post-schooling life.

After the introduction of ML in 2006, this was reviewed by the Curriculum and Policy Statement (CAPS) in 2011. The revised curriculum in the CAPS document was implemented for the FET phase, i.e. Grades 10, 11, and 12. The CAPS document was implemented to replace the two current policies then in place. The timeline of the history of ML in South Africa is depicted in Figure 2.1 to illustrate the history of ML in South Africa (North, 2015). There were several reasons why the CAPS document was released. The DBE wanted to create a singular comprehensive Curriculum and Assessment Policy document for each subject to replace Subject Statements, Learning Programme

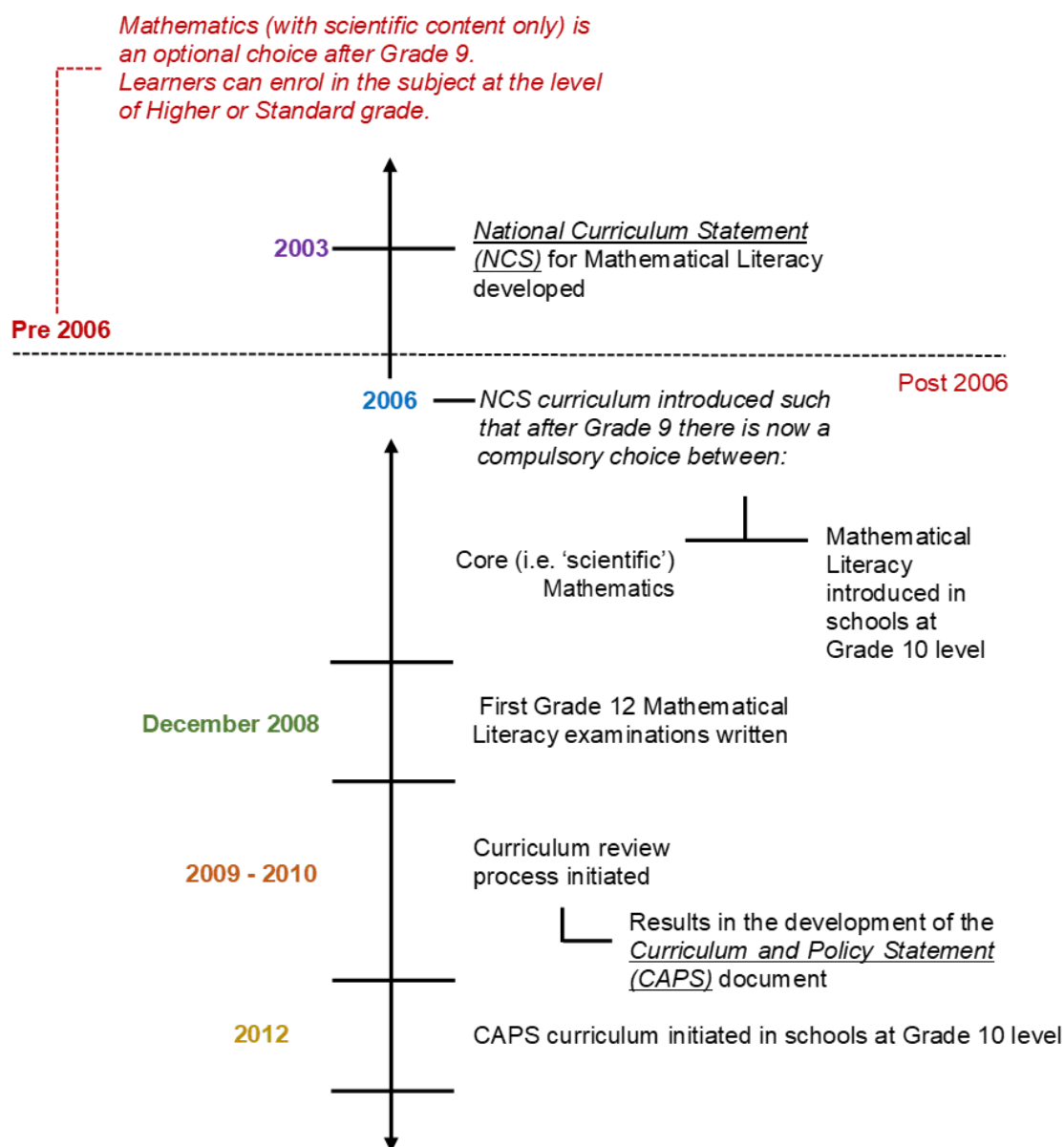
Guidelines, and Subject Assessment Guidelines in Grades R-12 (Department of Basic Education, 2011b).

The Department of Basic Education (2011b) stated that the CAPS curriculum document aimed to

[e]nsure that children acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives. (p. 4)

Figure 2.1

Timeline of curriculum change for the subject ML (North, 2015, p. 93).



This definition links directly to the terminology used in the definition of ML. Terms such as “contexts” and “own lives” reflect the embodiment of what ML is about in South Africa, thus reinforcing the concepts of ML in the CAPS document and guiding teachers further towards the expected outcomes in a ML classroom.

2.3.2 South African perspective on and definition of Mathematical Literacy

When the apartheid era came to an end in 1994 there was a drive towards educational reform. The African National Congress (1994) policy document on the framework for Education and Training determined that there was a need to address the demand for equal Democratic Education for all citizens and to create future economic growth through quality education. To overcome these challenges the vision of the African National Congress (ANC) was to place emphasis on science, mathematics, and technology. This vision of economic growth prescribed learning that was education- and training-based so that it could be both school-based and work-based. Its purpose was to ensure that learners and workers engaged with technology through connecting the teaching of science and mathematics to the life experiences of the individual and the community (African National Congress, 1994). The themes such as concrete real life experience and community are reflected in the terms used in the definition of ML as we know it today. I go on to discuss this in detail later in this section.

During this time, the Curriculum Development Working Group in the Department DoE produced a discussion document (Curriculum Framework Council, 1995) that recommended the introduction of integrated learning areas. Venkatakrisnan and Graven (2006) observed that mathematics initially became a part of the “Numeracy and Mathematics” learning area that later became ML. This was the motivating factor for ML, on paper at least, that led to its creation as a subject in South Africa.

The issue of defining ML has received considerable attention from researchers over the past years (Bowie & Frith, 2006; Graven & Buytenhuys, 2011; Machaba, 2017; Pillai et al. 2017). These researchers noted that there is more than just numeracy to learn in the ML classroom. They observed that ML entails contextualised mathematical learning. This definition of ML corresponds with the DoE’s definition of the ML curriculum (Department of Education, 2003):

ML provides learners with an awareness and understanding of the role that Mathematics plays in the modern world. ML is a subject driven by life-related applications of Mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems. (p. 9)

Other definitions of ML include terms such as “allow individuals to make sense of, participate in and contribute to the twenty-first century world” and “numerically based arguments” and “the ability to reason, make decisions, solve problems, manage resources, interpret information, schedule events and use and apply technology.” Frith and Prince (2006) referred to these terms as fundamental to deriving the definition of ML. In substantiation of this, the Department of Basic Education (2011b) indicated that “learners must be exposed to both mathematical content and real-life contexts” (p. 10). Vithal and Bishop (2006) described ML as a “hot topic” (p. 2). The National Curriculum Statement states that ML empowers learners to deal confidently with contextualised mathematics that affects their daily lives (Department of Education, 2003). Clearly, given the official definitions of ML, managing the subject requires a learner with proficient literacy skills.

ML in South Africa emanated from a curriculum that was established by a group of officials appointed by the DoE. Graven and Buytenhuys (2011) reminded us that this was problematic since the names of the members of this group are not known and there was no consultation with the various mathematics education structures that existed in the country to support the creation of a new curriculum. Upon this, a review of ML was conducted, from which two policies arose: the subject Assessment Guidelines (Department of Education, 2008); and a Teacher Guide (Department of Education, 2006) for ML. Botha and Putten (2018) claimed that in order to have a successful conceptualisation of ML in South Africa, it should be dependent on the mathematisation of contextual situations. The process of mathematisation is meant to minimise ambiguity by translating mathematics from the real world to a mathematical setting (Botha and Putten, 2018). According to Botha and Putten (2018), mathematising real situations in which mathematical problems occur consists of the process of transferring between the mathematics and real-life contexts. The objective of ML as a subject is to establish a process of moving from pure mathematical calculations to using these computations in a context-based on real-life.

2.3.3 The aims and goals of Mathematical Literacy

Aims

The aim of ML is to create a learner who, in their adulthood, possesses the necessary skills to cope with everyday mathematical demands the real world presents to them. This can be accomplished by implementing contextualising learning in the classroom. These abilities are further defined by the Department of Education (2005):

- The ability to understand information represented in mathematical ways.
- The ability to engage critically with mathematically based arguments encountered in daily life.
- The ability to communicate mathematically. (p. 8)

Goals

In the broader definition of the purpose of ML in South Africa according to the Department of Basic Education (2011b) there are certain goals that ML wants to achieve. These goals are:

- **To be a person who can face the mathematical demands of everyday life.** Simsek (2021) noted that it is important to prepare learners for assessments in mathematics. However, teachers have to teach beyond this goal and its attendant mindset to make learners build confidence in mathematics and face the mathematical demands they will face in their future as adults. In relation to this, the Royal Ministry of Education of Norway declared that to build confidence in mathematics, the mathematical tasks should be realistic to motivate learners (Royal Ministry of Education, Research and Church affairs, 1999). Mathematics in the classroom should be connected to the demands of everyday life and learners should construct their own mathematical concepts around this connection.
- **To be a person who becomes a contributing worker.** Hodaňová and Nocar (2016) stated that gaining knowledge in Mathematics enables a person to find a job and become successful in the labour market. Hodaňová and Nocar (2016) also indicated that in order to gain knowledge in mathematics it is pivotal that learners participate in the learning process. The emphasis on learner participation in the classroom is vital for the creation of a learning environment that creates, in turn, a positive space for learning and gaining knowledge.
- **To be a participating citizen in a developing democracy.** The connection between mathematics education and the promotion of citizenship education is not new (see Burkhardt 2018a, 2018b). For Maaß et al. (2019), using authentic situations in a mathematics classroom creates an opportunity for critical thinking. These authentic situations give rise to the opportunity for instilling democratically based values in the mathematics classroom by connecting mathematics education to local context to promote democratic citizenry (Department of Basic Education, 2011b).

2.3.4 Progression regarding the Mathematical Literacy curriculum

The ideal of ML is to create a process of development during which a learner can display progression in problem-solving skills. The Department of Basic Education (2011b) stated that progression refers to the process of developing more advanced and complex knowledge and skills. I discuss this with reference to three levels.

- **Content**

ML is developed across the grades in terms of mathematical concepts and skills. Each year a topic will be considered in more context and details. If there is no progression in content from Grade 10 to 12, the progression will take place in the form of context and or problem-solving processes.

- **Contexts**

The context in which a problem is placed can vary from familiar to unfamiliar to build on mathematical progression but the content can be similar. However, moving from Grade 10 to Grade 12 the context becomes less familiar to make the learning experience more demanding. The DBE illustrates this thus: “There are some topics in which the focus in Grade 10 is on contexts relating to the personal lives of learners and/or household issues (e.g. personal finance like cell-phone accounts; household budget), in Grade 11 on contexts relating to the workplace and/or business environment (e.g. business finance such as payslips; taxation), and in Grade 12 on contexts relating to scenarios that encompass wider social and political contexts incorporating national and global issues (e.g. exchange rates and inflation)” (Department of Basic Education 2011b, p. 10).

- **Confidence in solving problems**

Learners at the end of Grade 9, having learnt mathematics in a scientifically motivated curriculum, will display minimum confidence in solving mathematical problems. Hence, to produce through the application of a ML curriculum a mathematically literate learner requires guidance from teachers, especially in Grade 10 since appropriate mathematical and non-mathematical techniques are needed to solve problems that learners will encounter in both familiar and unfamiliar contexts. The Department of Basic Education (2011b) document states that in Grade 10, learners are expected to complete multi-step procedures and scaffolding-based questions involving a single step calculation. In Grade 12, learners are expected to perform with confidence, multi-step calculations involving numerous and complex calculations. The DBE thus intended to use content, context, and confidence in problem solving to display evidence of progression in learners in ML in order to achieve the objective of learner efficiency in problem solving in mathematics.

2.3.5 The difference between Mathematics and Mathematical Literacy as Further Education and Training subjects

When a learner completes their schooling up to the end of Grade 9, a choice of Mathematics Subject must be made for the FET phase (Grades 10–12) of their education. There are two choices—Mathematics and ML. It is therefore critical that learners, parents, and teachers understand and know the difference between the two subjects offered in FET phase, and to understand what their prospective outcomes are for learners. I go on to discuss the differences between the two subjects in various contexts.

Table 2.2

Comparison of the definitions of ML and Mathematics (Department of Basic Education (2011a), p. 8).

ML	Mathematics
The competencies developed through ML allow individuals to make sense of, participate in and contribute to the twenty-first century world—a world characterised by numbers, numerically based arguments and data represented and misrepresented in a number of different ways.	Mathematics is a language that makes use of symbols and notations for describing numerical, geometric and graphical relationships. It is a human activity that involves observing, representing and investigating patterns and qualitative relationships in physical and social phenomena and between mathematical objects themselves.

Definitions of comparison between mathematics and ML

ML was intended to create a learner who can be a contributing citizen in South Africa by using mathematics effectively in a real-life context. The introduction of ML was meant to develop a “self-managing person”, “a contributing worker” and “a participating citizen” (Department of Basic Education, 2011b, p. 10). For Brombacher (2006), ML and mathematics as FET subjects in South Africa were designed for different purposes partly because Bernstein’s (2000) constructs of recognition and realisation were used to analyse the nature of mathematics and ML. These descriptions of ML and Mathematics are described in Table 2.2. It also needs to be noted that the definition of ML ignores the notion that ML also possesses its own language, one that uses symbols and notations for describing numerical, geometric and graphical relationships. It can be argued that

ML has a more predominant focus on the former mentioned as the Department of Basic Education (2011a) states that effective communication skills are required by learners to interpret and communicate answers and calculations by selecting and using appropriate visual, unit display, symbolic, terminology and language (p. 5 and 21).

2.4 Unpacking some of the language complexities related to the teaching and learning of Mathematical Literacy

With the introduction of ML in schools in South Africa, a renewed emphasis has been placed on the use of real-life context-based education (Department of Basic Education, 2011b). The objective of ML in South Africa is to build competencies in learners, such as the ability to reason, make decisions, solve problems, manage resources, and interpret information (Department of Basic Education, 2011b). Robertson and Graven (2019) pointed out that moving teaching towards a learner-centred direction involves considerable challenge. One of the most prominent challenges involves the use of contextual based teaching and learning in classrooms in which the language used is different from that used in most learners' homes in South Africa. The Organisation for Economic Co-operation and Development (2009, 2013) also stated that learners who are mathematically literate will meet the final objectives envisaged in the aforementioned objectives of the Department of Basic Education (2011b). However, the Organisation for Economic Co-operation and Development (2009, 2013) also stated that to achieve this objective, the range of contexts in ML questioning needs to extend from pure mathematical computations to having no mathematical structure since the latter requires the learner to identify and introduce the mathematical structure that is relevant to the questioning. Thus, learners need to be able to solve mathematical computations that range from relevant everyday life situations to unusual ones and from simple to complex calculations. In targeting these competencies, different contexts, each with its own specific demands, need to be considered. In this study I consider a context as the frame for an event that is being examined that provides resources for its appropriate interpretation (see Bansilal & Debba, 2012). More specifically, a task context within a problem-solving situation is the setting in which a problem is embedded that provides learners with information that may enable them to determine what is needed to solve the problem at hand (Pozas et al. 2020). Since the subject ML is assessed using text-based scenarios, ML tasks are characterised by extensive use of language to describe the contexts, offer the instructions, and draw upon context with specific nuances within it. One of the demands of working with real-life contexts is that each context has its own particular language with its own context-specific meaning (Bansilal & Debba, 2012), so the language used in different contexts offer different challenges. Hence, any study which looks at the teaching of ML will

necessarily have to consider the interaction between language and context. I explore some of these language complexities that are embedded within the teaching and learning of ML in the sub-sections that follow.

2.4.1 The relationship between language and mathematics performance in South Africa

Lafon (2009) has observed that many South African parents prefer to have their children attend schools where English is the medium of instruction because they believe that this will give their children better opportunities post-school. In South Africa, African languages may be used as the language of learning and teaching during the first three years of compulsory schooling. From Grade 4 onwards only English and Afrikaans are used. Statistics from the 2018 census revealed that only 20.3% of South African citizens speak either English or Afrikaans at home (Statistics South Africa, 2018), so the vast majority of learners experience a switch in the Language of Learning and Teaching in Grade 4. Spaull (2016) explored this phenomenon with Grade 4 learners by conducting a pre-test in the learner's home language and a post-test in English a month later. There was no intervention conducted during the month between tests. In the pre-test and the post-test there were sub-sectioned sets of questions. These were divided into 23 high-language and 16 no-language questions. Spaull noted that learners improved slightly in the no-language section of questions from the pre-test to the post-test. However, a decline in performance was evident in the high-language section of questions from the pre-test to the post-test. One would have expected learners to perform better in the post-test since it was completed a month after the pre-test and during that time they would have acquired new skills and consolidated old ones. Furthermore, familiarity with the pre-test could have been presumed to give an opportunity to the learners to improve on the post-test and it was assumed that non-English participants learned as much in the intervening month as their English peers, and that they would remember as much of the test as their English peers. However, learners achieved an average score of 33% for the pre-test and an average score of 22% for the post-test. Although the pre-test and post-test were mathematics assessments, the results in the high-language section of the tests displayed evidence of a language barrier to academic performance. This further emphasises the size of the challenge that 79.7% of learners in South Africa face. The findings of the research study indicate that there are several factors that must be considered when it comes to determining the relationship between language and academic performance in mathematics. The data analysis indicated that the most important finding that emerged was the composite effect of home background and school quality in South Africa. In numbers, Spaull (2016) measured the effect of a dysfunctional schooling system in "years' worth of learning" lost and indicated that the lack of numeracy and literacy skills placed a learner at a disadvantage of two to three years. He concluded

in his findings that “the intention is not to negate the importance of language, but rather to situate the language effect within the discussion of a generally dysfunctional schooling system” (p. 17). In summary, then, language is a major contributor to the poor performance in mathematics in South Africa.

Reddy et al. (2016) also determined that language is a major contributing factor to poor performance in mathematics. They determined, in a research study, that only 31% of learners in South Africa’s Trends in International Mathematics and Science Study 2015 (Reddy et al. 2016.) cohort report spoke Language of Learning and Teaching at home. These learners achieved significantly better results than did the learners whose home language differed from that used in learning and teaching at school. Robertson and Graven (2019) indicated that these findings direct us to two important points. First, a home language should be part of learning at school and, second, where the learner’s home language does not coincide with Language of Learning and Teaching in the classroom, opportunities to develop and improve skills in it need to be prioritised. Robertson and Graven (2019) stated further that a failure to attend to these two priorities will almost certainly contribute to the exclusion of some learners.

2.4.2 The language complexities presented in Mathematical Literacy

It is crucial to establish the relationship between mathematics and language and even more so to determine its significance. As Austin and Howson (1979) illustrated, the relationship between mathematics and language is clearly recognizable. They stated that the relationship between mathematics and language can be described as “the language of mathematics” that identifies written mathematical symbols and specialist mathematical vocabulary. Planas et al. (2018) indicated that the European Society for Research in Mathematics Education (ERME) identified three broad paradigms in determining the relationship between mathematics and language.

- The language of the learner
- The language of the teacher and the classroom
- The language of mathematics

2.4.2.1 The language of the learner

The first point indicated by ERME is that the object of the study is the language of the learner. Planas, et al. (2018) identified two lines of interest that have emerged by developing a theory of understanding of language as socially founded and a theory of learning as a discourse of change. The third concept raised by ERME, the language of mathematics, is what learners need to learn.

In the ML classroom, many languages are used by learners. For learners to succeed in a ML classroom, they need not only to be familiar with and competent in their use of ordinary English but must also have fluency in what can be termed mathematical language (Bermejo et al. 2021; Moschkovich, 2007; Schlepppegrell, 2011; Xu et al. 2021). The mastery of the language of mathematics, and the capability to switch between languages, requires strong linguistic skills. These skills are essential for learners if they are to communicate with each other, and cope with more advanced mathematics (Afni & Hartono, 2020; Mandy & Garbati, 2014; Planas & Setati-Phakeng, 2014). Jourdian and Sharma (2016) indicated that a key challenge in relation to language may make ML texts hard to understand. Learners struggle with the complexity of the language used in mathematics since they see it as a new language that has to be mastered; even English-speaking learners find mathematical language challenging (Mandy & Garbati, 2014; Moschkovich, 2007; National Council of Teachers' of Mathematics, 2008; Oguguo, 2020; Schlepppegrell, 2011). Learners learning to speak English as a second language need to master the complexities of the English language, but many have to work with the language of mathematics without having mastered ordinary English (Kahiya & Brijlall, 2021; Mandy & Garbati, 2014; Reddy et al. 2016). The dissimilarity between ordinary English and the language of mathematics creates a problematic situation for learners as they struggle to familiarise themselves with the language of mathematics. If the medium of instruction in the classroom is English, learners who speak English as a second language will be disadvantaged since they do not speak the language of instruction and will require more processing time to comprehend mathematical concepts compared to learners who speak English as a first language (Barwell, 2005; Opitz and Schindler, 2021). Jourdian and Sharma (2016) further indicated that learners miss out on mathematical learning because they spend copious amount of time attempting to understand the mathematical questions. Thus, in summary, the learner's proficiency in English determines the way she or he will perform in mathematics, or for this research study, in the ML classroom.

The curriculum of ML presents a challenge to the learners in South Africa who select it as a subject because of its emphasis on problem solving. Botha and Putten (2018) conducted a research study in which they indicated that contextual mathematic problems must engage the learners in the areas of

thinking, speaking, and doing. For Boaler (1993) consideration of the individual involved should precede decisions about the variety of contexts to be used. In contrast to this, the Department of Basic Education (2011b) stated that contexts should be familiar and unfamiliar, and they should increase in both demand and inaccessibility. Botha and Putten (2018) discovered that this causes learners to disengage with the work and the mathematisation process and mostly just want to get to the actual sums without considering anything contextual. Bansilal et al. (2012) also showed that although learners need opportunities to engage with real-life contextual settings, when they are presented with unfamiliar contextual settings their engagement in the classroom is limited.

Further to this, Sfard (2014) suggested that people's needs and requirements determine the level of ML they can attain. Gardiner (2004) noted that it is difficult to determine what mathematical knowledge and which skills people should possess to be deemed mathematically literate, because our interests in daily life differ. As mentioned earlier, here are studies that attempt to determine the influence language plays in learning mathematics with a focus on learners whose first language is different from Language of Learning and Teaching (Barwell, 2020). Barwell (2020) stated that learners will have discussions with other learners and teachers, will interact with printed materials or textbooks, and will write to display answers since all these actions form part of learning in a mathematics classroom. Mthethwa (2007) has shown that the language in which the contextualised assessment task in mathematics is presented, can result in two possible responses from learners. First, learners can fail to model the mathematical problem correctly because of the language used in constructing it. If the learner cannot recognize the nature of the problem, he or she cannot solve or respond to it in the correct manner. Second, as Fauziyah and Jupri (2020) have also indicated, learners also struggle with the interpretation and communication of the answer because of low language competence. These two scholars also observe that for learners to effectively learn mathematics effectively, it is imperative that they acquire the tools to communicate their ideas to their teachers. It is clearly evident that a considerable challenge for learners in ML is to grasp the meaning of ML questions and, at the same time, communicate their solutions to their teachers.

2.4.2.1(a) The Discourse of the learner

The understanding of mathematical concepts is fundamental to learners' participation in the ML classroom. Sfard (2008) noted that learning with understanding over emphasises the importance of conceptual understanding over formalisation and skills. This leads away from discourse and focuses attention purely on the conceptualisation of learning. Her findings concluded that a learner's grasp of mathematical concepts is improved when discourse is promoted through persistent participation.

Discourse in terms of this research study is defined by Planas et al. (2018) as the many uses of language that coincide in the learning process and through which the learner communicates comprehension of this process. Stein (2007) stated that participation in a mathematical community through discourse is viewed as being as important as the conceptual understanding of the mathematics itself. Wachira et al. (2013) said that a key element of discourse in mathematics is the need to use mathematical language and articulate mathematics concepts in order to learn both the language of mathematics and the mathematical concepts. Thus, discourse in mathematics can work when mathematics and language are learnt in the same lesson.

2.4.2.1(b) Multilingualism in mathematics teaching and learning

Having different languages spoken in a classroom presents a challenge to the task of imparting mathematical concepts effectively to learners. Ingram et al. (2019) indicated that previous research focused predominantly on the content of mathematical talk and not the interactional context in which this conversation occurs. She further noted that for learners whose primary language is also Language of Learning and Teaching, adopting this specified mathematical discourse in a peer discussion is not a problem. For a learner whose primary discourse is not represented in school, a sense of discourse conflict can arise. Planas et al. (2018) defined this linguistic diversity as the languages used in the classroom to interact with mathematics but also “the languages for communication: official languages of instruction, languages of teaching, and languages of thinking and learning” (p. 5). They indicated that learners in a mathematics classroom can switch from one language to another in different moments of communication during a lesson and combine aspects of these languages for different purposes. Maintaining discourses of monolingualism is detrimental to the understanding of mathematics. Further to this, Phakeng and Moschkovich (2013) pointed out that monolingual English speaking learners often experience regional language varieties in terms of, for example, regional accents and tonal differences related to socioeconomic status, age, and other aspects of identity, such as, for example, teenage slang and song lyrics. These examples illustrate that language diversity is the norm, not the exception. Phakeng and Moschkovich (2013) concluded that language diversity is relevant to bilingual or multilingual classrooms and that language diversity presents challenges in the classroom. It is inherent in the very nature of human communicative activity and competence.

2.4.2.2 The language of the teacher/classroom

ERME's second point of focus is the use of language in the classroom setting including that of the teacher. Planas et al. (2018) noted that learner populations are becoming more diverse both inside and outside of the classroom and that this leads to having many discourses in a classroom. This variety creates opportunities for interpretation and for negotiations of meaning in the mathematics classroom and, added to this, is the discourse of mathematics itself. Jones and Seilhamer (2019) stated that teachers need to understand the role of the language of mathematics in the classroom particularly when teachers teach in a multilingual setting. Planas et al. (2018) showed that learning in the mathematic classroom occurs in different social settings. Learning, interaction, and communication all take place where the teacher has more advanced linguistic skills. For Gellert (2020), the interpersonal functioning of language in the classroom contributes to the understanding of social aspects of mathematic education. This involves the capabilities of the teacher in managing classroom interactions and the ways in which learners from different social and cultural backgrounds gain opportunities for learning mathematics in the classroom.

The conditions in which learners are placed can influence their learning abilities and opportunities in the classroom. Jung and Schütte's (2015) research concluded that there is an increasing trend to focus on the improving of conditions for learning mathematics. They noted that the teacher and the teacher's language are part of a centralised phenomenon in studies towards more optimal conditions for mathematics learning. Schütte's (2006) analysis of the linguistic instruction in a classroom showed that there are limited learning opportunities for a multilingual learner because the linguistic instruction of the teacher orients itself towards perceptions of unity of a monolingual learner. He further indicated that these linguistic instructions do not consider diversity in discourse. Marsh (1994) designed the Content and Language Integrated Learning theory that refers to situations in which a subject such as mathematics is taught as a foreign language and leads to simultaneous learning taking place—that of the subject content and of the foreign language. Although the language of mathematics is not deemed a foreign language, the discourse language it provides can be integrated into the lesson to help learners learn simultaneously the mathematical content and the language in which it is presented. Prochakova (2013) supported this by indicating that Content and Language Integrated Learning can draw on language teaching methods as well as the content of mathematics didactics. Again, there is an opportunity to achieve more than just teaching mathematical concepts in the ML classroom. Integrating language into the ML classroom can achieve a symbiotic learning environment.

2.4.2.3 The language of mathematics

ERME's third point of focus concluded that the language of mathematics itself is a form of communication that learners use to learn mathematics. It is said that Galileo Galilei claimed that mathematics was the language with which God wrote the universe. Leshem and Markovits (2013) indicated that mathematics is a language of numbers, symbols, notations, and grammar. By using numbers and mathematical symbols, "words" and "sentences" can be written. They further stated that when appropriate, several "sentences" combined can form a "mathematical story" (p. 213). Halliday (1978) determined that mathematics is a register consisting of a set of meanings appropriate for a specific function of language, combined with wording and structures that express these meanings. Pimm (1987) further claimed that there has to be a recognition that the complexities of mathematical language need also to take into account the specialised forms of communication of written mathematics with an emphasis placed on algebraic notation. Ferreira & Freitas, (2020) examined the language of mathematics and claimed that mathematics is not a natural language but is, rather, a formal language that is artificially constructed and that uses natural everyday language in teaching mathematical language. Leshem and Markovits (2013) stated that mathematics also includes grammar that describes mathematical logic and that is used, in turn, to determine if mathematical statements are valid or not. Jamison (2000) claimed that linguistic terms can be used to describe mathematics and argued that not many see mathematics as a language. He also suggested that treating mathematics as a language would support learners in understanding it. He said,

I want to show how making the syntactical and rhetorical structure of mathematical language clear and explicit to students can increase their understanding of fundamental mathematical concepts. . . . Regrettably, many people see mathematics as a collection of arcane rules for manipulating bizarre symbols—something far removed from speech and writing. (p. 45)

For Planas et al. (2018), the language of mathematics can be analysed further by looking at the functioning of language in the construction of mathematical knowledge and reasoning and by distinguishing mathematical language from everyday language.

Functioning of language in the construction of mathematical knowledge and reasoning

Research into what influence language functions have in the construction of knowledge and reasoning in mathematics has varied from analysis of single signs and their use to research studies of the qualities and purposes of whole genres. A research study conducted by Rezat and Rezat (2017) determined the importance of subject-specific genres for integrated mathematics and language teaching. Steinbring's (2005) research into the construction of new mathematical

knowledge in classroom interaction and research was influenced by his epistemological perspective while Planas et al. (2018) provided insight into the role that specific words, symbols, or diagrams play in learner's construction of new mathematical concepts. Nührenbörger and Steinbring (2007) explained this epistemological perspective in their research study on how the interpretations by a teacher and two learners of the decomposition of 8 into $4+4$ varied because of differences in their respective reference contexts. The teacher used the experience of using mathematical principles to determine why $4+4$ should only be used once in a list of decomposition. The learners persistently interpreted two occurrences of $4+4$ as distinct, referring to the difference in the notations used rather than focusing on the mathematical objects.

Distinguishing mathematical language from everyday language

Mathematics is a language of communication that is observable in our everyday lives. It is evident in newspapers and television broadcasts in which graphs, percentages, and other mathematical concepts are used to convey information. Leshem and Markovits (2013) made it clear that mathematics as a language of communication is emphasised in mathematics curricula around the world. Planas et al. (2018) added that there are connections and disconnections between everyday language and the specialised language of mathematics that can also occur when a specific word or communicative element has the potential to be used to make everyday or mathematical meaning. Albano et al. (2015) described a distinction between what they termed colloquial and literary registers as way of analysing and discussing errors made by university students in a task involving graphs and analytic properties of functions. The issue of real-life situations was addressed by Hiebert et al. (2003) who compared the average percentage of problems that were set up using real-life connections and language in the mathematics classroom. Most teachers observed used real-life connections and language to transfer mathematical knowledge to learners.

2.5 Challenges teachers face in supporting learners with Mathematical Literacy questions and how they support learners in the Mathematical Literacy classroom.

Research has identified that one of the challenges related to ML teaching is that there is a shortage of teachers to implement ML successfully in South Africa (Genc & Erbas, 2019). Bansilal et al. (2015) believed there is a dire need for trained ML teachers and this needs to be addressed by Government. Because of this shortage of trained teachers, mathematics teachers that were not trained to teach ML, are teaching it. This brings about several problems. Relevant to this research study is that skills in translating contextual features into mathematical models are generally weak in ML teaching in South Africa, according to Winter (2014). According to Vale et al. (2012) this lack

of skills is intrinsically linked to the inability to decode language used in ML problems in context into mathematical language. This prohibits teachers from teaching ML effectively in the classroom.

Teachers also view ML along with mathematics as having its own language. Genc and Erbas (2019) it was discovered that mathematic teachers view mathematics as having its own language and do not view mathematics as being related to real-life. The problematic situation for ML is that mathematics teachers are likely to reject ML as not being mathematical given their purist mathematical ideologies. They view ML as inferior to mathematics. Another problematic feature is that weak mathematic understanding among in-service ML teachers has also been reported by, for example, Vilakazi and Bansilal (2012). This is substantiated by Madongo (2007) who reported that teachers without sufficient skills or background in formal mathematics experience difficulties with teaching ML. It is noted that experienced teachers of mathematics struggle to teach ML because of its challenge regarding the integration of language to promote real-life context learning.

How the teacher structures the learning is another challenge; does one teach ML content in context or does one teach context in mathematics? Venkatakrishnan and Graven (2006) have noted that teachers are struggling with the question of whether mathematical content should be embedded within contexts or the other way around. Verster (2009) considered whether learners should be given a real-life context after which the underlying mathematics could be dealt with, or if they should they first be taught the mathematical content and concepts. Botha and Putten (2018) discovered that learners resisted real-life contextual settings and wanted to get to the mathematical calculation components of learning in ML. Thus, while the teachers find the challenge of real-life context difficult to deal with, learners themselves also struggle with real-life context in the classroom.

The broad spectrum of knowledge that ML teachers are expected to have is far beyond the scope of a mathematics teacher. Integration in the ML classroom requires a broad range of knowledge from other disciplines and practices (Gal et al. 2020) and selecting the correct real-life context setting for learners in the classroom (Mthethwa, 2019). This in itself creates a situation in which ML teachers' views of ML and its intended outcomes as a subject are inconsistent. Pillay (2017) discovered that the actions regarding teachers' teaching strategies in a ML classroom was influenced by their own philosophy of ML teaching. She further identified that teachers experience various challenges regarding the recognition of using information, rules, language, and reasoning that is relevant to the context of the ML curriculum content. Pillay (2017) noted that teaching ML presents itself as a unique challenge in comparison to mathematics as a core subject since ML teachers are faced with a demanding challenge to constantly consider and teach to a context orientated curriculum while

addressing issues of complexity arising in the contextual domain (see Table 2.3). For Machaba and Mwakapenda (2016), mathematics teachers teach either ML or both ML and mathematics despite the fact that most have not been trained officially in teaching ML. Mhakure and Mokoena (2011) supported the previous statements by differentiating between the two curricula since the ML curriculum content is driven by the everyday life experiences of learners, while the mathematics curriculum is driven by mathematical operations. How teachers address these complexities in teaching mathematics and ML are linked to various aspects of themselves. Mbonani and Bansilal (2014) indicated that a teacher's qualifications, experience, and perceptions of the two subjects and how they have been inducted into the discourses of mathematics and ML can determine how they approach teaching in the classroom. Pillay (2017) indicated that the aspects of how teachers teach ML can also include the teacher's subject content knowledge, the content complexity itself, the complexity of the conceptual concepts, and the complexity of the contextual language. Hechter (2011), after observing two teachers teaching ML determined that their experience and training were responsible for how different their views were on a specific contextualised topic. Each teacher drew from their own experience to inform the methodology they selected in teaching the contextual topic. This emphasises that teachers' training and experience shapes their perspective on teaching in the ML classroom.

Table 2.3

Didactic practices relating to mathematics teaching in a ML classroom (Mavugara-Shava, 2005, p. 225).

Frequently practised	Rarely practised	Never practised
- Teacher directs explanations and questioning followed by students working on given exercises. - Learners do exercises either individually or in groups to drill learnt work.	- Mathematical investigations - Linking concepts to other school subjects - Linking concepts to real-life situations, not to contrived ones - Overt mathematical communication that includes both oral and written work	- Extended mathematical projects and practical work as part of the teaching/learning practices - Open-ended problem questions - Mathematical modelling giving rise to real life problem

• Learners are led to discover mathematical ideas. • Problems include contrived applications to everyday life. • Mathematical concepts are linked to each other. • Learners are made to understand mathematical concepts, rules, procedures, and processes. • Teacher creates opportunities for students to enjoy mathematics. • Use of textbook. • Drill and practice of skills, processes, and operations in exercises that teachers give.	• Many approaches to problem solving	solving and not contrived real life problems • Use of computer-aided teaching/learning practices • Extensive mathematical investigations • Cross-curricular connections

2.5.1 Factors to consider that present as a barrier to learners' optimal performance in answering Mathematical Literacy questions

For a learner to succeed in ML, she or he needs to be engaged in the ML content and this requires skills in literacy and numeracy. The Organisation for Economic Co-operation and Development (2013) stated that the language in the definition of ML emphasises active engagement in mathematics. This statement places an emphasis on reasoning, describing, and prediction in mathematics and importance is placed on the formulation and interpretation of a mathematical

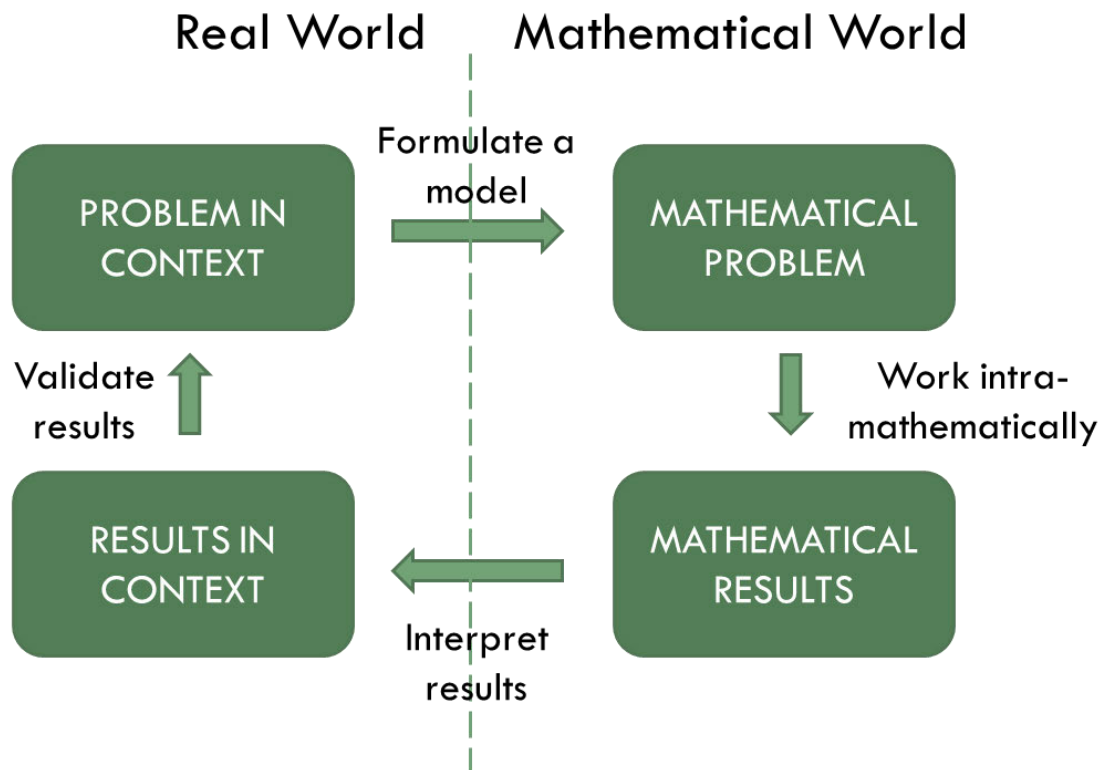
concept (see Figure 2.2). Formulation in mathematics requires one to identify methodology and opportunities and apply these in a mathematical process that results in an output to present or interpret. Interpretation in mathematics involves reflecting on mathematical solutions and interpreting the results or outcomes in the context of the mathematical problem. All this stems from a mathematical problem in context since skills are required to evaluate mathematical solutions and to reason in relation to the context of the mathematical problem. Then results can be evaluated, argued in context, or predictions can be made using deductive reasoning.

Mathematical problems that are contextualised in real-life, social, occupational, or scientific settings require the skills of formulating and modelling mathematical problems in context. One is required to display skills of working intra-mathematically to derive a solution to the problem, interpret the results in order to return to the contextualisation of the mathematical problem, and to validate the results derived and present a finding for the contextualised problem (see Figure 2.2). These steps require mathematical and literacy skills to move from context-based problem solving to solving the problem mathematically and then moving back to presenting the findings to a context orientated problem. It is vital for learners to possess literacy skills if they are to understand the task language (see section 2.6) in order to solve the contextualised mathematics problem successfully. The core focus of success in this the Organisation for Economic Co-operation and Development's description of ML in practice relies on task language and thus a learner's skills in literacy become the predominant factor in solving ML problems in context.

The question that arises from the aforementioned research is whether mathematics is affected by language ability or not. As Morris (2016) has noted, numerous studies have been conducted to explore the relationship between numbers and language. A limitation in research regarding learners is their understanding of mathematics that does not take into account their cultural background, including their home language that could be considered a deterrent to their problem-solving skills in mathematics. Cooper and Dunne (1999) noted that as a consequence, research findings are often presented with the preconceived notion that research findings are dependent on the participants' sex, because of the belief that gender determines cognitive predisposition rather than a number of factors. These scholars indicated that a sociological concern that is ruled out because of this preconceived notion is the consequence of the relations between a learner's cultural experiences, "which are given on entry to the school, and what the school demands of the child as the conditions of his or her success" (p. 5). An example of this is to consider the learner whose home speaking language is 'B' and the school demands the use of language 'A'. For Cooper and Dunne (1999), the learner is not linguistically deprived, but is relatively deprived of a fundamental resource that the school demands for so-called normal progress to take place in it.

Figure 2.2

ML in practice (The Organisation for Economic Co-operation and Development, 2013, p. 26)



2.5.1.1 Language as a barrier to learning Mathematics

There is evidential research that indicates that there is a correlation between a learner's ability in the language of instruction and his or her performance in mathematics. The United Nations Economic, Scientific and Cultural Organization (2016) released the Global Education Monitoring Report that indicated that up to 40% of the global population have no access to an education in a language that they speak or understand. Robertson and Graven (2019) indicated that as it is evident that there is a need to address this phenomenon and interest regarding the relationship between language and the teaching and learning of mathematics has increased significantly over the past several decades. They indicated that teacher-centred pedagogies in mathematics education have been replaced by learner centred pedagogies that place more emphasis on learners' discursive skills in the mathematics classroom. This movement has called for a more focused approach in paying attention to assisting learners to improve their linguistic proficiency in the mathematics classroom. ML as a subject in South Africa attempts to address this emphasis on learners' discursive skills in the mathematics classroom by describing the competencies required to gain success in the ML classroom as the

ability to reason, make decisions, solve problems, manage resources, interpret information, schedule events, and use and apply technology.

When they are teaching ML, teachers have to consider that mathematics has its own unique language. Patkin (2011) recognized that learners find some of the mathematical terms ambiguous. There are words that are used in both everyday language and mathematics, but their meanings can be different. She noted that the natural language that is spoken every day is blended into mathematics. She indicated that learners “drag” (p. 1) the meaning of words that are generated from an everyday language understanding into mathematics language. This often results in learners’ making mistakes or entertaining misconceptions in the mathematics classroom.

As mentioned frequently above, most learners in South African ML classrooms do not speak English as a home language so there are language gaps in the medium of instruction in the classroom. Prediger et al. (2019) identified that language gaps are of concern for multilingual and monolingual learners who are fluent in everyday language usage. Lin (2016) identified that since language differs according to its context, learners need to develop language proficiencies appropriate for use in the mathematics classroom. Relevant to this, Cummins (2001) noted the distinction between the use of everyday language and academic language. He indicated that basic interpersonal communication skills are used in everyday life. Examples of this occurs in conversation with friends, informal interactions in the playground, or communicating online using a social media platform such as Facebook, WhatsApp, Twitter or any other internet forum. In contrast to this, academic language is defined as a cognitive academic language proficiency that is used when academic topics are discussed in the classroom and in reading and writing about academic topics in school tests and examinations. Bansilal and Wallace (2008) conducted a research study that identified the barriers to learning for learners that hindered their performance in the Common Tasks for Assessment test² (CTA) in South Africa. They identified several prominent barriers including learners’ relation to difficulties in cognitive academic language proficiencies. Bansilal and Wallace (2008) identified these barriers to learning as being based on task language, information overload, and lexical density.

2.5.1.2 Task language

Task-based language of instruction in ML possesses its own form of mathematical language. Stein et al. (2009) stated that mathematics education focuses on using mathematical problems as a basis

² Standardized tests that are compulsory in South Africa for all Grade 9 learners.

for more ambitious, student-centred instruction. Chu et al. (2019) noted that it is expected that if these mathematical problems are sufficiently rich in integrating relevant real-world contexts and developing mathematical ideas, learners will gain a deeper understanding beyond the basic understanding of standard mathematical procedures. However, they acknowledged that such mathematical problems and tasks require interaction in a specified targeted language. This implies moving beyond the basic language requirements of an emphasis on grammatical correctness.

Since task-based language of instruction in ML possesses its own form of mathematical language, this can become a barrier to learning for learners who do not speak Language of Learning and Teaching at home. Bansilal and Wallace (2008) observed that poor language skills acted as a barrier to understanding the context of the task. Also, they discovered that poor language skills impeded learners' understanding of the instructions. Bansilal and Khan (2013) discovered in a research study that poor language skills hinder the understanding of instructions regarding a task and that this is a vital deterrent to performing well in assessment tasks. In addition to the aforementioned, Haag et al. (2015) noted that the length of a text and the number of noun phrases appear to be significant predictors of low achievement in mathematics. For Abedi and Lord (2001), reading difficulty based on sentence and text level has often influenced the learners' achievement in assessments and tests. Prediger et al. (2019) noted that syntactical complexities on the sentence level have to be considered when taking into account learners' assessment and tests performances. This includes complex prepositional clauses (Shao et al. 2021), conditional clauses (Schleppegrell, 2011) and complex issues of cohesion on the sentence and text level. The learner in ML thus faces mathematical demands and mathematical language demands.

2.5.1.3 Information overload

Given the understanding that mathematics possesses its own form of language and that learners are expected to possess the literacy skills to comprehend this language structure to gain success in ML, it is imperative to view how assessments in ML and mathematics in South Africa are constructed from a literacy perspective. As previously indicated, if a learner lacks proficiency in the language of instruction, the language shortfall is likely to hamper his or her performance in the mathematics classroom. Combined with this, Bansilal and Wallace (2008) determined that there are two forms of information that appear in contextual tasks in mathematical assessments. The first type of information, called *context information* refers to the information that supplies the context or paints a picture about the context. The second type of information is called *crucial information*. As the term suggests, this information is necessary to solve the task.

In ML examinations and assessments there are many words and instructions. This literacy demand causes learners to struggle to determine if information is *context information* or *crucial information*. Bansilal and Wallace (2008) noted that participants did not possess the necessary literacy skills to recognize what the *crucial information* was to complete a question successfully. This creates a situation in which learners experience information overload. Vale (2018) indicated that close attention needs to be paid to the language demands of ML assessments.

2.5.1.4 Lexical density

Mathematical language in ML is very content rich and makes for complex reading. Bansilal and Wallace (2008) indicated that if we are to gain a deeper understanding of learners' literacy struggles in mathematics, it is useful to consider the *lexical density* of the instructions. Neri et al. (2021) stated that mathematical texts have a very high *lexical density* or amount of content information in a text. *Lexical density* measures how tightly the lexical items (content words) have been packed into a grammatical structure or, in other words, measures how much information is provided in a particular piece of writing. Lexical words are more commonly known as content words or information words. In Bansilal and Wallace's (2008) research study, they found that a large number of lexical items was found per clause. They indicated that informal spoken language contains a lexical density of about two content words per clause. Written English contains a lexical density of about four to six words per clause. A question from the CTA in South Africa was analysed and found to contain a lexical density of approximately 13 content words per clause. Bansilal and Khan (2013) in their research study used lexical density to determine the sentence complexity of the CTA in South Africa. They discovered that the passages of questioning analysed were too dense to be understood by the average Grade 9 learner. Feedback from participants in Grade 9 supported this finding by stating that they found the questioning in the CTA to be a major obstacle to understanding what they were expected to do in the mathematics assessment. Because of this intense lexical density, the participants in the research study did not attempt to demonstrate their mathematical competence since they failed to understand the instructions related to the questions presented to them in the test. Prediger et al. (2019) commented on several studies that further support the effect lexical density has on achievement in mathematics. This is further supported by Haag et al. (2015) who discovered that an increase in the difficulty of lexical features in mathematics questions increases their difficulty. This intense density of words makes learning in mathematics challenging for learners who struggle with the language of instruction in ML.

2.5.2 Language factors that influence learning in the Mathematical Literacy classroom.

There are many intricacies to consider when one is determining how English as a language, especially for second language learners influences their learning in the ML classroom. Maluleke (2019) supported this statement by indicating that learners do not easily understand challenging mathematics word problems when teachers use only English. To avoid learners falling behind in ML because of deficiencies in their comprehension of English, there are a certain number of factors that Jourdain and Sharma (2016) identified that need to be explored if we are to challenge ineffective learning in the ML classroom.

Ordinary English versus mathematical English

Learners enter the mathematics class with an existing vocabulary. Anthony and Walshaw (2007) noted that learners are familiar with certain words in English that have a different meaning in mathematics. Kotsopoulos (2007) explained that these familiar words that have different meaning in the mathematics classroom can seem like a foreign language to learners. Kenney (2005) listed words such as mean, operation, element, and similar as examples of words that can present confusion and difficulty for learners in the mathematics classroom so is it important for them to be taught that these words in a mathematical context differ in meaning from everyday English. Additionally, Kaur & Prendergast (2022) indicated that learners will be introduced to several new words that they have not come across before. Jourdain and Sharma (2016) indicated that learners are required to learn these new words and their specific meanings and how they are applied in the mathematics classroom if they are to experience success in mathematics. These findings create a new challenge to learners and teachers since the fact that some words mean different things creates a more complex learning environment in the ML classroom. This becomes even more complex for learners who are second language English learners who need to learn the language of instruction itself and the different meanings that an English word can possess.

Language translation

Since most learners in ML classrooms in South Africa are not English speaking, the translations from English to home language is a challenge. Jourdain and Sharma (2016) noted that learners who do not speak English as a home language have to contend not only with the challenges related to vocabulary within the register of mathematics, but also with the change of meanings between registers. All learners also have to contend with concepts that do not exist in their home language

vocabulary. Mbekwa (2008) suggested that in South Africa it is desirable to teach learners in their home language and they must be given support materials that are written in their home language. This translation of mathematical text makes it easier to access and understand the mathematical register. Fasi (1999) studied the language of Tongan learners and found that concepts such as standard deviation and comparative terms such as very likely, probable, and almost certain have no equivalent words in the Tongan language. Latu (2005) and Fasi (1999) suggested implementing special courses in English mathematical discourse to connect the underlying meaning of mathematical concepts in English to the learners' home language. The bridging from home language to English in a ML classroom presents itself as a challenge.

Syntax

Learners in a ML classroom struggle with translation and the complexities of English syntax makes this even harder (Padula et al. 2001; Paradis et al. 2017; Schleppegrell, 2011). Stabler (2019) have suggested that syntactical structures of English as a language clashes with the conventions of mathematical language structures. Mosimege (2016) observed that South Africa has 11 official languages and many unofficial languages with minimal syntax correlation between them, with English being of vital importance. Although English is ranked fifth as a home language spoken in South Africa (Statistics South Africa 2018), it is used as the language of business, politics, and education. As Mosimege (2016) pointed out, the Nguni languages, IsiZulu, isiXhosa, siSwati, and isiNdebele, have many similarities in syntax and grammar. He also noted that the Sesotho languages, Setswana, Sesotho sa Lebowa (referred to as Sepedi in the Constitution), and Sesotho have a lot in common in terms of syntax and grammar. The challenge for learners is that English has no syntactical similarities to other languages in South Africa and this becomes a barrier to learning in the mathematics classroom. What adds to this challenge as Planas (2021) have noted, mathematics as a language has its own grammar, syntax, vocabulary, word order, synonyms, conventions, idioms, abbreviations, and sentence and paragraph structures and this places more pressure on learners and creates more of a learning barrier in the classroom. Since most learners in ML classrooms in South Africa speak English as a second language, these challenges are huge.

Reading mathematics

Reading in the ML classroom has become one of the most important skills if a learner is to achieve in ML as a subject. The language of mathematics is expressed in words, graphic representations, and symbols (Kenney, 2005); National Council of Teachers of Mathematics, (2000). Kester-Phillips et

al. (2009) noted that mathematically written text presents learners with an additional challenge since, while they are working in English, they must simultaneously understand English as a language and mathematics as a language. Then, after facing this challenge of language comprehension, learners have to undertake the required mathematical task. Tachie & Otto (2021) identified redundancy as the main characteristic of learners using English as the language of learning in the classroom that has a significant influence on how learners misread the language of mathematics. Jourdain and Sharma (2016) stated that in contrast to this, learners learn to skim in English, identifying key words and linking them to key points, such as one can do when reading a novel. But, as Padula, et al. (2001) have pointed out, the language of mathematics is precise and concise, and each word has a specific meaning and purpose with minimum to no redundancy. They also noted that each sentence contains a large amount of information contained in overloaded and dense sentences. So, learners who transfer the skills of skimming in English to reading the language of mathematics may be disadvantaged because they overlook key information.

Cultural influence can have an effect on how learners read in the ML classroom. Latu (2005) and Padula et al. (2001) determined that some cultures have less redundancy in their languages and these learners are most likely to pay attention to all the words in mathematics and thus manage to read the language of mathematics. Further to this, as Barwell (2005) argued, learners need to learn how to read and solve word problems in mathematics effectively. He claimed that relying on decoding words only to extract arithmetic operations is not sufficient if a learner is to succeed in extracting the correct information from mathematical text in the English language. Adams (2003) advocated for a more active role in reading in mathematics. She identified the following points that prove to be difficult for learners reading the language of mathematics:

- formal definitions;
- the interaction between words, numerals, and symbols; and
- the significance of order in mathematics.

Latu (2005) stated that a learner's ability to read in Language of Learning and Teaching is vital to their performance in the mathematics classroom. If a learner wants to achieve success in mathematics but his or her reading skills are problematic, frustration, and reduced self-expectation are likely to occur. Bolstad (2020) indicated that in order for learners to succeed at word-based problem-solving questions in mathematics, the most vital point on which to focus is on reading the task carefully. Learners need to be proficient at reading in the language of assessment and examination in order to succeed at ML.

Word problems

In South Africa, ML assessments are word-based problems. These words are found outside the language of mathematics, and this makes the mathematics in ML assessments problematic for learners. Barwell (2005) noted that learners from a linguistic background that is different from English often have difficulties solving word-based problems because they are not familiar with the words used in the problem-solving questions. Jourdian and Sharma (2016) found that these students struggle to comprehend the vocabulary or syntax with which they are unfamiliar before they even consider the mathematical challenge presented to them in the problem-solving question. This can have an adverse effect on learners in the classroom and this can, in turn, also invalidate the assessment method of word-based problem solving. Abedi and Lord (2001) discovered that the gap in mathematics performance between first and second language English speaking learners widened when teachers used word-based problems. When the word problems were written in a simpler way, however, but the mathematical content kept the same, the gap between first language and second language English speaking learners narrowed. Jourdian and Sharma (2016) made the point that since word-based problem solving is valuable in mathematics, it is of utmost importance that appropriate word-based problem-solving questions that are contextually relevant to the learners in the classroom must be used; this can reduce misunderstandings in mathematics.

2.5.3 Teachers reading questions aloud to support learners in Mathematical Literacy

Shepherd and Van De Sande (2014) pointed out that reading aloud gives the teacher the opportunity to translate written text into fluent spoken utterances. Senawati et al. (2021) stated that the teacher is key to facilitating the reading aloud that can act as the bridge between the written text and the learner's understanding of that text. McClure and Fullerton (2017) observed that such reading aloud in the classroom gives learners the opportunity to see how others, such as the teacher, make meaning from a text. Duke and Pearson (2008) indicated that reading along with the teacher in the classroom helps learners to acquire the strategies and skills that good readers possess. They claimed that this will improve a learner's overall comprehension and will support learners when they read on their own in the future. In a mathematical context, Freitag (1997) indicated that reading mathematical text is a complex process that requires "readers to develop special skills in order to comprehend what is read" (p. 18) and that in order to have learners reach their full potential and develop into mathematical learners who are capable of comprehending complex mathematical text, teachers need to support them in acquiring these skills so that learners will have enough confidence to attempt to solve ML questions on their own.

2.6 Problems in identifying mathematical demand and linking it to the contextual setting

Research indicates that in order to succeed in mathematics, learners must be competent in the use and understanding of language in mathematics (Anthony & Walshaw, 2007; Erath et al. 2021; Kotsopoulos, 2007; Schleppegrell, 2011). This correlation has led to renewed emphasis on language in mathematics. This has, in turn, focused on how learners learn in the mathematics classroom and has led to the new approach to learning that involves learners discussing mathematics with their peers. Rohid et al. (2019) stated that this emphasis on mathematical communication presents itself as a challenge to the mathematics classroom. Hoogland et al. (2016) indicated that the use of too much language in a mathematics lesson is seen by many teachers as presenting an additional difficulty, especially for low performing learners.

Further research has indicated that there is a growing demand placed on learners' linguistic skills in the mathematics classroom (Anthony & Walshaw, 2007; Buono & Jang, 2021; Moschkovich, 2007; National Council of Teachers of English, 2008). Jourdian and Sharma (2016) pointed out that learners, regardless of whether their home language is being used in the mathematics classroom or not, are expected to listen, talk, and read using mathematical language (National Council of Teachers of Mathematics, 2000). The mathematical language skills learners need in ML are, according to the Department of Basic Education (2011b) to allow them to gain competencies such as "the ability to reason, make decisions, solve problems, manage resources, interpret information, schedule events and use and apply technology" (p. 8). Jourdian and Sharma (2016) noted that learners must be able to understand mathematical concepts and, at the same time, demonstrate the ability to connect their newly acquired mathematical knowledge to their everyday life and communicate this newly acquired knowledge to others. The Department of Basic Education (2011b) elaborated that a learner learning in the ML classroom in South Africa will explore and solve real-world problems, so it is essential that the mathematical contexts in ML questioning is varied to accommodate for the complexities offered in ML contextual examination questioning. For Jourdian and Sharma (2016), this complex level of reasoning through mathematical discourse, cannot be easily achieved by many learners. This is because everyday language conflicts with the mathematical register (Anthony and Walshaw, 2007; Kotsopoulos, 2007; Schleppegrell, 2011).

Hoogland et al. (2016) said that it is vital to foster learners' abilities to use their mathematical skills to solve problems in contextual settings. They further indicated that in order to achieve this it is imperative that teachers have the necessary skills to select teaching materials and assessment materials that are best suited to their learners. They went on to say that resulting problems that arise if teachers do not do this is that learners struggle to read and make sense of context-based

questioning. Manfreda et al. (2021) believes that despite teachers' best intentions, if resources are selected poorly, rather than encouraging context-based learning in the classroom, it can hinder learners from learning. Manfreda et al. (2021) reiterated that a connection between mathematical demand and contextual setting needs to be created and in order to do this effectively there are factors that affect the degree of complexity of the mathematical demands or contextual setting that must be considered; these are the level of difficulty of the mathematical demand and the recognizability of the connection between the mathematical demand and the contextual setting.

2.6.1 Use of code switching

Ndebele (2021) acknowledged that teaching and learning in multicultural and multilingual classrooms is both challenging and demanding. Rounds (1996) noted that the different cultural mix along with the native languages spoken in a classroom and the different levels of language proficiency of the learners all contribute to its complexity and teachers attempt to use teaching methods to combat these challenges and among these is the use of code switching. Bhatti et al, (2018) indicated that in communities where two or more languages co-exist, people frequently switch from one language to another to meet communication needs. Bas (2020) further defined that code switching, to which he refers as language mixing, is a form of alternating the use of two or more languages within one conversational utterance. Gumperz (1982) noted that code switching is the juxtaposition within the same speech exchange of two different grammatical systems and subsystems. It also means that people use the systems and subsystems of two different languages to make comparisons in their interactions.

Moschkovich (2013) stated that since learning mathematical terminology is an important component in mathematics learning, mathematics instruction should address more than vocabulary and should support second language English learners' participation in mathematical discussions as they learn English. Krause and Farsani (2021) said for this to take place, teachers need to see learners' home language as a vital resource for meaning making rather than as a deficiency. To accommodate learners in a ML classroom, code switching is used to promote engagement. Learners' use of code switching and the teachers' attitudes towards code switching have implications for learners who learn using English as the medium of instruction in the classroom. Moschkovich (2013) stated that learners may use code switching for various reasons including seeking clarification and communicating an explanation to teachers. Hussein et al. (2020) observed that code switching can promote learner-to-learner and learner-to-teacher interactions in the classroom, especially for English second language learners. Planas and Setati-Phakeng (2014) indicated that code switching

can be used as an advantageous strategy in teaching and learning in the mathematics classroom by using the learner's home language as a resource rather than it being a barrier to learning. Yusob et al. (2018) further noted that most learners in their study were in favour of using code switching as a method of communicating in the classroom. Learners believe code switching can be used to facilitate their learning in the classroom.

Code switching can be used by learners who speak English as a home language in classrooms as long as they have a working knowledge of other languages. Planas and Setati-Phakeng (2014) reported that in the mathematics classroom where the instructional medium used is English, learners who are first and second language English speakers use code switching to clarify their own understanding and to express their ideas in the classroom. Code switching also takes place between the mathematical register and English as a language and this adds to the challenge of language as a barrier to learning since the complexities in the mathematical classroom increase because different layers of language and mathematical register are being combined (Barwell, 2005; Karizza et al. 2021; Moschkovich, 2002).

Jegede (2011) indicated that code switching has a function in facilitating and supporting thinking and communication and that for code switching to be applied effectively, the class members need to share the same mother tongue. Lee (2010) cautioned that too much use of code switching can bring about confusion in the classroom because words often have different meanings in different languages. This makes it vital for teachers to know when the use of code switching in the classroom is beneficial.

2.6.2 Code switching in the Mathematical Literacy classroom

English as a language is part of the learning component in a ML classroom. Radford and Barwell (2016) argued that language is more than a window of opportunity or an obstacle since language, talk, text, and the production and interpretation of symbols are fundamental components in the creation of learning, teaching, and assessment in mathematics. Jourdian and Sharma (2016) stated that the traditional view of difficulties in mathematical learning is that these are associated with the cognitive demands of mathematics itself. It is now recognized that language and mathematics are connected in mathematics learning and teaching so the challenge in mathematical learning has evolved into the twofold one of dealing with language and mathematics together, not just the cognitive mathematical demands in ML.

In South Africa, Maluleke (2019) collected data through classroom observations and semi-structured interviews to evaluate the impact code switching has on learners with low levels of

proficiency in English. He discovered that teachers were aware of these low levels and felt that they were supposed to guide and support these learners step by step in the process of learning challenging mathematical concepts. The evidence from classroom observations revealed that teachers code switched in order to support learners with linguistic difficulties when they were using mathematical terminology. Code switching is used to fill the gaps or to emphasise important phrases or points in the mathematics lesson. The teachers who were interviewed indicated that they felt compelled to code switch “to help learners keep abreast of the subject matter presented” (p. 5). Maluleke concluded that teachers have a dilemma because the subject policy does not allow code switching in South African classrooms.

Code switching has become a universal phenomenon (Junaidi, 2019; Shafi et al. 2020). When code switching is effectively implemented, it does benefit the teacher and the learners in the classroom (Nurhamidah et al. 2018; Shafi et al. 2020). Simasiku et al. (2015) discovered that teachers perceived that code switching enhanced learners’ academic performance because this led to an improvement in their acquisition of English. It was also determined that code switching improves the way learners answer questions, enhances teaching and learning of English as a second language, has learners better understand the subject matter, and has them interpret difficult English concepts in the language they fully grasp and understand (Junaidi, 2019). Maluleke (2019) further determined that code switching serves as a mediation tool that promotes learner participation in ML classrooms, helps teachers evaluate if learners understand the concepts taught in ML, and helps teachers bond with learners to promote a love of mathematics.

2.6.3 The use of code switching to support the understanding of the contextual setting of Mathematical Literacy questions

Ncoko et al. (2000) argued that South Africa has moved away from its apartheid bilingual past with English and Afrikaans as the two official languages, and that it has entered a multilingual future with its 11 official languages. They noted, however, that there is a complication in the South African educational setting since English is still viewed as a necessary medium of instruction. Many South African parents perceive English language skills as necessary for learners to succeed in a local and international environment (Kamwangamalu, 1998). Ncoko et al. (2000) believed this to be so since English contains a material power that provides future learners the opportunity to engage in the middle-class occupations of this country. Consequently, this has elevated English, and it is perceived as a “‘High’ language and the other official languages in South Africa as ‘Low languages’ (Kamwangamalu, 1998, pp. 279–80). However, Maluleke (2019) indicated that “teachers encounter challenges when they use English as the medium of instruction because learners fail to comprehend

the challenging mathematical concepts presented to them in a language which is not their home language” (p. 1). The Department of Basic Education (2014) stated that teachers must focus on using the correct language while teaching and assessing ML, while acknowledging that the language used in teaching and learning in the classroom remains a challenge to learners who are not taught in their home language. Mawela and Mahlambi (2021) elaborated that since code switching is not a formal tool for teaching ML, learners recall and understand mathematical concepts better using their home language as the supportive medium of instruction. For Mashige et al. (2019) by using code switching and elaborating in the learners’ home language as a supportive medium of instruction supports learners in better understanding the task and clarifying any doubts or misconceptions created by using English as the initial medium of instruction. Matope and Chiphambo (2022) stated that learners who speak first languages other than English in South Africa, find it beneficial when teachers use code switching between English and their home language. Gumbi (2021) noted that research conducted during a 2017 study produced empirical evidence that code switching became the norm in order to address the language gap in a South African classroom.

In Southern Africa, Venkat and Spaul (2015) found that the Southern and Eastern African Consortium for Monitoring Education Quality (SACMEQ) test results in South Africa's mathematics indicates that learners perform poorly in this subject. For Mawela and Mahlambi (2021) learners’ poor performance in mathematics means that we have to look for new teaching strategies. Nishanthi (2020) promoted the belief that teachers must focus on their language use in the classroom and the teaching of subject content. Modupeola (2013) and for Mawela and Mahlambi (2021), this will lead to teachers paying attention to teaching mathematics with a learner centred approach while using code switching to promote the learners’ understanding of what is being taught to them. Mahlambi and Mawela (2021) stated that code switching supports learners’ understanding in the classroom. According to the Department of Basic Education Annual National Assessment reports (2012, 2013, 2014), Foundation Phase learners’ mathematical performance was better than that of learners in the Intermediate Phase and Senior Phase. Mawela and Mahlambi (2021) implied that home language teaching in Foundation Phase enables learners to understand the mathematical demands required from them and thus improve their mathematical performance. The Department of Basic Education Annual National Assessment reports (DBE, 2014) indicated that introducing English as the medium of instruction at Intermediate Phase poses a severe threat to the performance of learners in mathematics because of the change in medium of instruction from Foundation Phase home language instruction to Intermediate Phase English language instruction. Cummins (2000) elaborated by indicating that learners’ also struggle most when the mathematical task includes mathematical language. Mawela and Mahlambi (2021) deduced that there is a need for

code switching to enhance learners' understanding of mathematical concepts. They indicated that most South African learners come from rural areas where English is rarely spoken. Hence, learners struggle to communicate and understand mathematical subject matter taught in English. Supporting this, Simasiku et al. (2015) stated that code switching has proven to be an effective teaching and learning technique in schools where a second language functions as a medium of instruction.

In a ML setting, Gumperz (1982) stated that code switching is used in order to reinforce, emphasise, amplify, and clarify a message that has already been relayed in one code, but has not been understood. Ahn et al. (2020) and Mawela and Mahlambi (2021) indicated that a vital component of determining the amount of code switching used in the classroom depends on the teachers' bilingual language proficiency. This also depends on the amount of context used in questioning within the classroom setting as Ncoko et al. (2000) have noted. Moschkovich (2007) indicated that tasks that learners found challenging would be interpreted into their home language and they would then attempt to communicate this difficulty using the language of instruction. Mabule (2015) indicated that this process supports learners in identifying the mathematical demands in a given task. Trisnawati (2017) observed that a classroom with learners of the same ethnic identity often code switch from English to identify as a collective. Mawela and Mahlambi (2021) claimed that in the classroom the teacher code switches in order to make mathematical concepts understandable to learners.

To summarise the use of code switching to support the identification and understanding of the contextual setting in ML questioning, Pavese (2021) argued that knowledge is derived from the ability to make sense of information. Twohill and Shúilleabháin (2021) stated that once we comprehend the information and its context, we can apply it or use it in a meaningful manner. McCabe (2013) noted that once learners have the ability to make use of given information and the information is understood, including the context of the information, the application of the mathematical demands in the information becomes more accessible and thus information becomes knowledge.

Once the information is understood, including the context of the information, the mathematical demands in the information become more accessible and thus information becomes knowledge. McCabe (2013) further stated that knowledge enables a learners to identify which data is relevant for a specific contextual setting.

2.7 Support provided by the Department of Basic Education to Mathematical Literacy teachers

Since the conception of ML entailed minimum or no consultation with stakeholders involved in the teaching of any form of mathematics in South Africa or internationally, there were bound to be problematic issues arising in its curriculum documents. Graven and Buytenhuys (2011) indicated that the initial design of the ML curriculum originated with officials who were appointed by the DoE. These officials did not consult with any of the various stakeholders in mathematical structures in South Africa. To complicate matters further, the names of these officials are unknown. From its conception, the lack of consultation with relevant stakeholders created uncertainty and doubt in relation to development of the ML curriculum. Graven and Buytenhuys (2011) noted that shortly after the ML curriculum was designed, a ministerial committee was elected to review it. Following the review, the ML Subject Assessment guidelines (Department of Education, 2008) and a Teacher Guide (Department of Education, 2006) for ML were developed. Christiansen (2007) identified that there were contradictory messages in the ML curriculum documents. Jansen (2009a, 2009b) questioned the validity of its assessment and the value of ML as currency. Sidiropoulos (2008) questioned the status of the subject since many teachers believe that ML is a watered-down version of mathematics as an FET subject. Brombacher (2005) supported this by indicating that ML is viewed as a different kind of mathematics, not as a lower level of mathematics. For Bansilal and Khan (2009) real world contextually based questions often come with their own language and complexities. This language sometimes involves adult-related concepts and Boaler (1993) suggested that it is vital to avoid contexts using adult metaphors in mathematics and, in this case, in ML.

It is evident that the ML curriculum has faced criticism since its inception as a subject. In relation to ML resources, Chisholm (2011) indicated that quality resources are vital in an educational context, and even more so in schools that are surrounded by poverty. She notes that the choice to use a decentralised system of textbook procurement introduced in the post-apartheid era has furthered the unequal quality of education for learners in South Africa. Another problem with ML textbooks was identified by Verster (2009) who pointed out that there is a dilemma for ML teachers in selecting textbooks; should the learners first be given the contextual setting and then have to deal with the mathematics enclosed in the setting or should they be allowed to address the mathematical demands in ML? Bowie and Frith (2006) alluded to the fact that the authors of ML textbooks are also unsure in relation to this dilemma and this makes it difficult for teachers to select the appropriate resources to support learners effectively in ML. Verster (2009) indicated that because of this, many teachers resort to designing their own resources with limited time, knowledge, and technical skills in order to support learners in the best way they can. Further to this, Brijlall (2014) indicated that teachers are

expected to be experienced enough to identify unreliability in the textbooks that present misinformation. Furthermore, Mbekwa and Julie (2009) noted that learners' familiarity with the contextual settings in ML questioning is something that is judged by teachers.

2.8 Conclusion

In this chapter I began to offer some understanding of the role ML plays in South Africa according to local and international scholars. Further to this, I explored the history of ML in relation to its purpose in being implemented in South Africa along with its key elements and its aims and goals. Since most mathematics teachers in South Africa teach both ML and mathematics, I considered it vital to explore the differences between the subjects and the implications of these differences as articulated by a number of experts.

I considered the points of view of many local and international scholars on the relationship between learners' proficiency in English and their performance in the ML classroom and outlined the challenges teachers face in this regard given that most South African learners are not first language English speakers. I discussed code switching in terms of the benefits and problems inherent in this practice and offered detailed accounts of the points raised by a number of scholars in South Africa and elsewhere.

I considered the problems surrounding the teaching of ML in South Africa as documented by a number of scholars in various countries and approached this from the three vantage points of the curriculum, the learners, and the teachers. I concluded this chapter by looking at how the Department of Education in South Africa has failed to support ML teachers.

Chapter 3: A conceptual framework for the description of CALPs in ML

3.1 Introduction

The focus of this study is on teachers' perceptions of, and responses to, the language demands of the subject ML. It is therefore necessary for me to explore theories related to developing proficiency in language as well as those related to the complexities of engaging with ML. In this study I draw on Cummins's (1979, 1984, 2008) language proficiency framework to offer a deeper understanding of the role language plays in teaching and learning ML and the ways in which ML teachers take account of the language demands in their teaching. In addition, I draw on the work of Pillay and Bansilal, 2019 and Debba and Bansilal, 2012, to establish connections between these language demands and the complexities of engaging with ML tasks in general. My main argument is that ML learners require proficiency in the test language described by Cummins (1979) as Cognitive Academic Language Proficiency (CALP) in ML. In the sections that follow, I first discuss Cummins's (1979, 1984, 2000) work on one distinct aspect of language proficiency, BICS (Basic Interpersonal Communication Skills), before elaborating on the notion of CALP in ML.

3.2 Components of language proficiency

Early work in the area of language proficiency by writers such as Oller (1979) suggested that all individual differences could be explained by one underlying construct referred to as global language proficiency. However, Cummins (2008) realised that language proficiency is not a uniform construct, but one that has different facets. This is evident in the fact that learners acquire social language relatively quickly, but it takes several years to acquire academic language. Furthermore, learners have acquired their first language by the time they enter the schooling system, but they develop their academic language to meet the demands of the classroom over their entire school career and beyond. These differences illustrate that acquiring social language is different from acquiring academic language, and these two facets of language proficiency have different demands (Cummins, 2008; Ranney, 2012). This observation led Cummins to propose two conceptually distinct components of language proficiency, BICS and CALP. BICS include conversational fluency in a language that is required by learners outside of their educational setting. CALP emphasises the

additional challenges faced by second language learners who need to acquire BICS in English, but also have to learn the nuances of academic language proficiency. CALP is contextual literacy that is found in the classroom or so-called academic setting and Cummins (2000) defined it as “the extent to which an individual has access to and command of the oral and written academic registers of schooling” (p. 67). One of the distinctions between BICS and CALP is that BICS is somewhat cognitively undemanding, whereas CALP is much more cognitively demanding (Cummins, 2008). Cummins (2013) stated that combined, BICS and CALP enable a learner to understand key concepts and ideas linguistically and is the core component essential to experiencing success in an educational setting.

It is important to note, as mentioned above, that second language learners face additional hurdles in acquiring the necessary CALP (Cummins, 1984; 1991) because they must first deal acquire BICS while also learning about the subtleties and nuances of CALP. Second language learners need to catch up to their English-speaking peers as far as the academic aspects of LOLT in school are concerned. The relevance of this framework for non-English speaking learners is supported by the National Academies of Sciences, Engineering, and Medicine (2017). In one study teachers noted that learners’ peer-appropriate conversational fluency (related to BICS) in English developed quickly, but a period of five to seven years, on average, was required for non-English speaking learners to approach acceptable levels of CALP in the classroom (NASCM, 2017). Hence the constructs of BICS and CALP are relevant to my study insofar as they address code switching and bilingual education, concepts on which I have already elaborated on earlier in this thesis.

3.3 ML tasks

The actual tasks that teachers use in the classroom have become a central resource in the teaching of ML. In some cases, teachers may provide practice exercises to their learners to consolidate certain concepts, but it is often the case (as will be seen in this study) that ML lessons are organised around the discussion of assessment tasks, many of which are drawn from past examination papers. Since ML tasks are necessarily linked to real life contexts (DBE, 2011b) the possible scenarios are set out using textual and, at times, diagrammatic information. The structure of contextual tasks is described by Anderson (2005) in the table below.

Table 3.1*Structure of contextual tasks (Anderson, 2005).*

Introductory material		
1. Written	2. Pictorial	3. Real Object
Stem		
1. Question	2. Incomplete Statement	3. Directive
Response		
1. Short Answer Supply (fill in the blanks) Select (multiple choice) Matching/True-False		2. Extended Response Written Performance

The three major components of contextual tasks are introductory material, stem, and response (see Table 3.1).

Some ML assessment or classroom questions may include all three components, but some may not necessarily be reliant on all three. The material in the introduction can be presented in written format, as a pictorial presentation, or displayed in the form of a real object. These present the opportunity to give the background or required information to the question that will follow. These introductory materials create the opportunity to display the contextual domain or scenario in ML.

The stem is the description of the task to be completed. This can be accomplished by asking a question that requires a solution, completing an incomplete statement, or carrying out an instruction.

The response is to give feedback to the stem requirement, to adhere to it, and to satisfy the requirements set out in it. This response can be given in the form of a short answer like filling in the missing blank, selecting the correct answer in a multiple-choice format, or matching true or false statements. For most cases in ML an extended response is required. This extended response can be accomplished by a written response or by carrying out a performed action.

3.4 Acquiring CALP in ML

My perspective in this study is that the assessment and classroom tasks in ML necessarily involve learning a new register that is specific to ML, some aspects of which may overlap with those encountered in mathematics. I argue that meeting the language demands embedded in ML activities and content involves acquiring CALP in ML. In this section I will elaborate on these demands that are linked to typical ML activities and content.

Firstly, working in ML entails participating in mathematical conceptual domains in order to solve problems. Since the subject ML includes mathematics content encountered up to grade 9 level, learners need to be proficient in these basic mathematical concepts and the associated mathematics register. In other words, they need to be familiar with the mathematics domain. In section 2.4.2.3, I dealt exhaustively with the issue of the language of mathematics and the language used in mathematics. Since mathematics has its own unique language with rules and conventions that govern the use of the symbols, notation, and registers (Jourdain & Sharma, 2016), knowing mathematics involves understanding, using, and communicating with this language. For example, the expression $3x^2$ denotes that x is multiplied by itself and then multiplied by 3, while $2(5+3)$ denotes that we find the sum of 5 and 3 first before multiplying it by 2. These are just two simple examples of mathematical conventions. Mathematics also has its own register of words with unique meaning, for example the word “mean” refers to finding the average of a set of numbers. Patkin (2011) noted that learners find some mathematical terms ambiguous since these are words that are used in both everyday language and mathematics, but with different meanings; the natural language that is spoken every day is blended into mathematics. The unique language of mathematics can present additional challenges to second language English speakers when compared to their first language counterparts. Abedi and Lord (2001) identified that the gap in mathematics performance between first language and second language English speaking learners widened when researchers introduced word problems. When the word problems were written in a simpler way, however, while keeping the mathematical content the same, the gap between first and second language English speaking learners lessened. Even to English speaking learners, mathematical language is a challenge (see section 2.4.2.3) since it is seen by learners to be a new language that they must master (Austin & Howson, 1979; Mandy & Garbati, 2014; Moschkovich, 2007; National Council of Teachers of Mathematics, 2008; Schleppegrell, 2011; Oguguo, 2020). Thus, learners who are studying ML will necessarily need to be proficient in the language

used in, as well as the language of, mathematics. In other words, CALP in ML includes proficiency in the mathematics register.

Secondly, working with ML content and tasks necessarily involves working in different contextual domains. Some research conducted on learners' difficulties in responding to ML assessment and classroom tasks, can be used to identify features of CALP in ML, linked to the context (Debba & Bansilal, 2012; Pillay & Bansilal, 2019). Each contextual domain has attributes that learners need to recognize and know how to use in order to work in the domain. Success in responding to these contextual tasks requires that they are able to understand the nuances of these contextual attributes that can be seen to develop cognitive academic fluency in the language used in these contexts (Debba & Bansilal, 2012; Pillay & Bansilal, 2019). These contextual attributes are elaborated on below.

Contextual signifiers are objects used in the context to convey specific information and whose meaning is bound to the context itself. An example of a contextual signifier is the term “infant mortality rate” which, in this particular context, refers to the number of infant deaths per 1000 births.

Contextual language refers to the ways “in which talk itself invokes context and provides context for other talk” (Duranti & Goodwin, 1992, p. 7). In this study the phrase *contextual language* refers to words or phrases that hold a particular meaning within the context. For example, “200 free kilometres per day” in the car hire scenarios refers to the situation in which the contract allows one to drive up to 200km a day without incurring additional charges.

Contextual rules are bound to the context and need to be applied and interpreted by the learner. For example, the rule used to calculate the inflation rate is given by thus: inflation rate = $\frac{P_1 - P_0}{P_0} \times 100\%$, where P_1 and P_0 refer to the prices of goods in the current and the previous year respectively.

Learners often struggle to extract the information about the attributes because they may be couched in dense language. Sometimes information is provided in the introductory material that is too far away from the instructions and learners may miss it. Sometimes learners may struggle to decode the instructions because of the language overload (Bansilal & Debba, 2012).

In this study the teachers' perceptions and responses to the language demands that they face as they try to mediate ML tasks in their classrooms, can be seen as their ways of helping their learners develop aspects of CALP in ML (Bansilal, 2013; Bansilal & Debba, 2012). Cummins's (1984; 1991) two-dimensional model of language acquisition can be applied to the setting of ML to help us understand the language demands associated with working with ML, and this is elaborated on in the next section.

3.5 The Cummins Model of language acquisition

Barwell (2016) noted that Cummins defines CALP language in relation to what people do with language rather with than how they display specific linguistic features:

The essential aspect of academic language proficiency is the ability to make complex meanings explicit in either oral or written modalities by means of language itself rather than by means of contextual or paralinguistic cues (e.g., gestures, intonation, etc.) (Cummins 2000, p. 69).

Further to this, Cummins (1981) indicated that there is a relationship between contextual support and cognitive demands in communicative tasks. In ML, these tasks form the basis of the interactions between the teacher and the learners in the classroom. The interaction between these two parties will be distinguished and measured by observing the extent to which meanings are communicated with support from contextual and interpersonal cues where face-to-face interaction or ML tasks are dependent on the quantity of information to be immediately processed through the communicative context (Cummins, 2000, 2001, 2008).

Context for this purpose is what the teacher brings to a task (internal) and the range of support that he or she incorporates into the task itself (external) (Cummins, 2008). In an ML classroom, the tasks can be set in contexts which could be simple and familiar. The contextual attributes employed in the contextualisation are simple and may be addressed by context reduced communication and reduced CALP demands. Context embedded tasks are set in more complex or unfamiliar contexts and therefore the contextual attributes are more difficult to navigate. These present high levels of CALP demand. This means that in the ML classroom academic language should be used to describe higher order thinking and abstractions as clearly as possible (Darmi et al., 2016). Hence ML learners need to develop

CALP in ML which involves decoding and using the contextual rules, signifiers and language with contextual tasks.

The simultaneous approach of combining two concepts such as ML learning and language proficiency (Bossé, Bayaga et al., 2018; Bossé, Ringler et al., 2018) proposed, can be captured in the Language Acquisition Framework, a four-stage learning sequence for ML that connects language acquisition and cognitive demand (Cummins, 1979, 1984, 1991).

Tasks in the ML classroom exhibit varying levels of cognitive demand. On the one hand there are cognitively undemanding tasks which require minimal cognitive involvement such as a calculation with 1 or 2 steps or simple recall of facts or formulae. On the other hand, cognitively demanding tasks involve communication that may be open ended and subjective, and requires them to engage in complex cognitive processes such as the interpretation of information, carrying out multi-step procedures etc. The previously mentioned descriptions of ML indicate that learners must be able to use elementary mathematical content that is based on a real-life context, solve familiar and unfamiliar problems, make decisions and communicate them, and use integrated content and/or skills in solving problems (DoBE, 2011b) showing that ML tasks can vary along the two dimensions (complexity of context and cognitive demand).

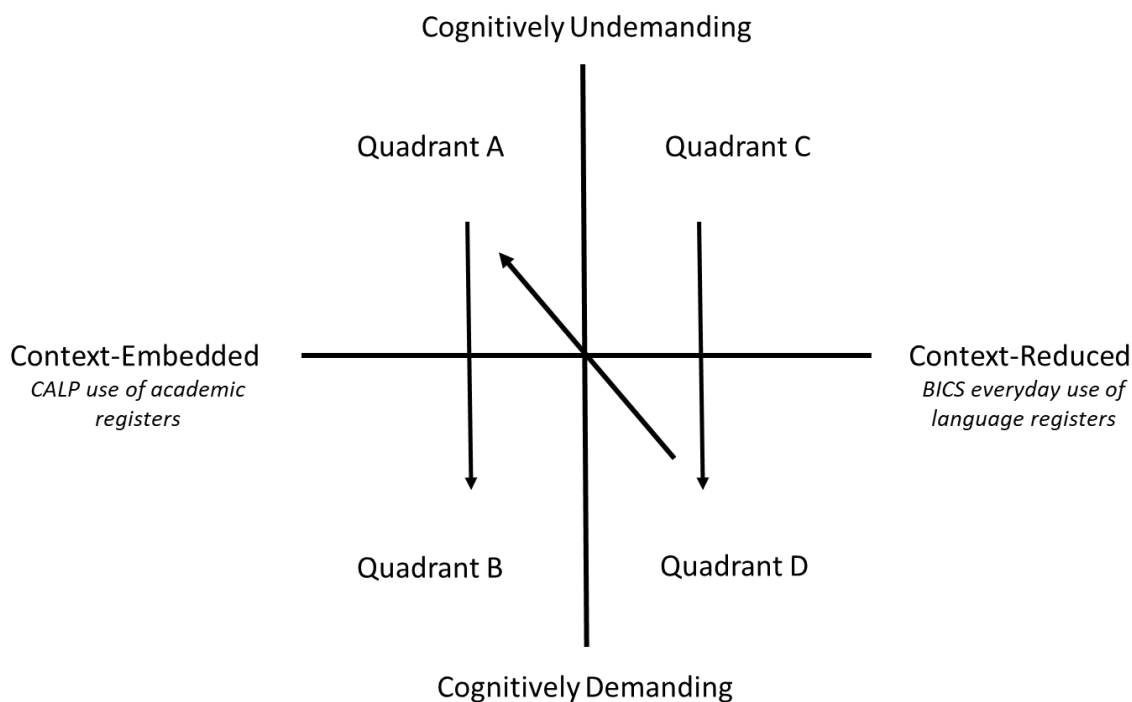
3.5.1 The Four Quadrants model

Cummins (1981, 1994) proposed a four-quadrant model (see Figure 3.1) in which each quadrant is formed by the intersection of two axes. The distinction in the BICS and CALP constructs elaborates that these two intersecting continua emphasise the range of cognitive demands and contextual support involved in language-based tasks and activities. The four-quadrant model's horizontal continuum ranges from context-embedded to context-reduced, and the vertical continuum ranges from cognitively undemanding to cognitively demanding (Cummins, 2013). The four quadrants or stages differ in the degree of contextual support and cognitive demand required for different language activities and are demarcated by the intersection of the two axes: level of context and cognitive demand. These stages are learning in: a context reduced, cognitively undemanding environment; a context reduced, cognitively demanding environment; a context embedded, cognitively undemanding environment; and lastly a content embedded, cognitively demanding environment.

I adapted this model for this research study to enable me to consider the different language activities associated with the ML tasks prescribed for learners. Cummins (1984) drew attention to the different uses of language that pose different types of challenges to the learner and that can be related to academic language use or contextual challenges. In ML, contextual language changes continually for each task or setting. The details of the data analysis process are presented in Chapter 4 (see section 4.10.3).

Figure 3.1

Cummins's (1994) Four-Quadrant Contextual and Cognitive Demands Framework (p. 41, adapted).



3.6 Conclusion

In this chapter, I offered my understanding of the role language plays in the ML classroom and my justification for my selection of the theoretical framework of this research study. I pointed out that the initial aim of the Cummins Model of Language Acquisition (1994) is to aid teachers to ensure that tasks match learners' developing levels of language proficiency and I explained how I adapted this model for the purposes of this research study.

Chapter 4: Data collection process

4.1 Introduction

In this chapter, I introduce and discuss the research methodology I used in this study that was designed to explore how teachers perceive and respond to language demands associated with the learning of ML. First, I discuss the research paradigm that guided the research study and describe the research design I selected. Then I discuss the relevance of the ethical considerations and explain my sampling criteria and techniques and I provide information about the inclusion criteria I used to select the participants. Third, I describe my data collection strategies and offer my analysis of the data.

The Department of Basic Education (2011b) defined ML as a subject that

[p]rovides learners with an awareness and understanding of the role that Mathematics plays in the modern world. Mathematical Literacy is a subject driven by life-related applications of Mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday solutions and to solve problems. (p. 9)

The significance of language as a teaching and learning component in ML is undeniable when the terms “life related applications”, “develop the ability and confidence to think numerically and spatially”, “interpret and critically analyse”, and “solve problems” are used to define the objectives to be achieved by learners in ML. Teaching ML with these objectives in mind creates enormous challenges for teachers. In this study, I attempted to understand how teachers view this challenge given that language plays such an integral part in the teaching and learning of ML. I explored how teachers perceive and respond to the language demands associated with teaching and learning ML.

4.2 Research questions

This thesis sought to address the following questions.

1. What are teachers' perceptions of the learners' struggles with the language complexities in ML?
2. How do teachers support the learners in addressing the language demands and complexities in ML?
3. What are teachers' suggestions on how learners could be more effectively supported in the ML classroom?

4.3 Research methodology

4.3.1 Research paradigm

This is a qualitative study embedded in the constructivist paradigm. Following Lincoln et al. (2011), I use the term paradigm to refer to the philosophical assumptions or set of beliefs that guide the actions and define the worldview of the researcher. Fraser and Robinson (2004) further elaborated that a paradigm is “a set of beliefs about the way in which particular problems exist and a set of agreements on how such problems can be investigated” (p. 59). Creswell and Clark (2011) indicated that the term “worldview” (p. 12) is a synonym for paradigm and they described it as how to think about making sense of the complexities presented in the real world. For Guba (1990) a paradigm is a set of beliefs that guides an action and for Haigh and Withell (2020) research is reinforced by a paradigm. With reference to this term, Mukherji and Albon (2015) spoke of the researcher experiencing a different way of seeing the world and making sense of that experience and, similarly for Kaushik and Walsh (2019), this shapes the researcher’s thoughts and perceptions about the world. Essentially, the selection of a particular paradigm represents the researcher’s worldview and, as Kamal and Lin (2019) indicated, this guides the researcher’s actions in relation to the phenomenon being researched, the data collection, and the analysis, so it has important implications as Kivunja and Kuyini (2017) indicates that the researcher’s actions can implicate every decision made in the research process.

For Lincoln and Guba (1985), the central component of a constructivist paradigm is the attempt to understand the participants’ subjective world of human experience. For Asghar (2013), a constructive paradigm involves individual perceptions of reality and interaction with the environment. Kivunja and Kuyini (2017) noted that the constructivist approach attempts to gain an understanding of how the participant being studied is thinking of the meaning he or she is making of a specific context rather than what the observer makes of it. A participant must be observed or studied in context so that what she or he thinks is “interpreted in the light of all the factors involved in the phenomenon” (Ashgar, 2013, p. 3122). In order to collect meaningful and rich data, the aforementioned literature was reflected upon as part of the process of triangulation in the collection of data for this study (see section 4.5.2). For Bisman and Highfield (2012) the constructivist approach supports the researcher in giving meaning to the way things are for the participant. It also supports the identification of factors that could not otherwise be described statistically, and thus the data cannot be generalised across entire populations. Bisman and Highfield (2012) pointed out that constructivist research places emphasis on the meanings embedded in textual and verbal accounts and involves the analysis of oral and personal histories and narratives obtained through data

collection strategies such as interviews. The analysis of data is therefore an interpretive act rather than a scientific one that consists of making sense of everyday life and experiences through hermeneutics by generating “rich and compelling interpretations [as] key to producing more rigorous forms of knowledge” (Kincheloe 2008, p. 21).

I used a constructivist paradigm to explore and understand how teachers perceive and respond to language demands associated with the learning of ML. I wanted to understand the views of participants on how they manage these and what strategies they implement to act on them. Mogashoa (2014) explained that contextual constructivism concerns itself with the social construction of knowledge and the application of attained knowledge. In this study’s being driven by the constructivist concern behind a “knowledge-centered” approach (Crotty, 2020, Gagnon Augustin & Cukier, 2021) lay the motivation not to select an interpretivist paradigm for it. Also, a constructivist paradigm is defined as a reaction to, and a disputing of, positivist ideas of knowledge production to produce research that is “meaning-centered” (Scauso, 2020) in being based on subjective experiences and interpretation.

As Karimova et al. (2020) observed, a teacher whose approach to teaching is constructivist will have a classroom that is interactive, and learner centered. Accordingly, I designed the research questions to obtain data from participants concerning their thoughts and actions in response to learners’ difficulties in relation to language usage in the ML classroom. In-depth interviews gave them the opportunity to share their experiences in contending with these language demands given that, as Cilliers (2021) noted, learning takes place in context and observations can capture the learners’ attainment of knowledge in a specific context. Kaushik and Walsh (2019) stated that a person’s perceptions of the world are influenced by social experiences. The knowledge attained by each person is unique and is created through their individual life experiences. With all this as a directive, I understood that my findings could be different for learners from different socio-economic and socio-cultural backgrounds.

4.3.2 Research method

For McMillan and Schumacher (2010), the effective collection of data can follow qualitative, quantitative, mixed method, and analytical paths; I selected the qualitative method to approach this research study while using a mixed method for the collection of data, including a questionnaire. This was used purely to enrich the questions in the interviews and lesson observations. Elkatawneh (2016) stated that the objective of qualitative research is to analyse the meaning of a participant’s experiences and how they view a particular experience. Berg and Howard (2012) defined qualitative

research as consisting of meanings, a concept, a definition, metaphors, symbols and a description of things or, in other words, all instruments that can elicit recollection to aid problem-solving. For Eyisi (2016), qualitative data collection instruments may be open-ended questions, in-depth interviews (audio or video), and field notes aimed at collecting data from participants in their natural settings. These data collection strategies supply a complete description of all participants involved, and this in turn, in this particular case, creates a more comprehensive understanding of behavior in the classroom. A qualitative research approach provides an ample supply of data about real-life participants and their experiences (De Vaus, 2014). For Eysis (2016) any systematic use of a qualitative research approach results in unique data. A researcher being dependent on collecting non-numerical primary data such as words and pictures serves as an instrument itself and makes such qualitative research suitable for providing factual and descriptive information (Johnson and Christensen, 2012).

A qualitative research approach is concretised through the resulting data. Johnson and Christensen (2012) and Maxwell (2013) have indicated that different researchers use different terms such as investigative, do-it-yourself, and bottom-up to describe the authenticity of the qualitative research approach. Eyisi (2016) noted that a qualitative research approach views participants' perceptions and behaviour in a social context and covers a wide range of phenomena in order to understand and appreciate them thoroughly and that participants' behaviours that consist of interaction, thought, reasoning, composition, and norms, are studied holistically. The close relationship that exists between the researcher and the participants in a qualitative research project, presents the opportunity for the participant to contribute to shaping the research.

In contrast to the benefits of a qualitative research approach, Johnson and Christensen (2012) found that qualitative researchers view the social world as being dynamic and not static. Related to this, researchers limit their findings to the particular group of participants being studied, instead of generalising to an entire population of possible participants (De Vaus, 2014). Another problematic feature regarding a qualitative research approach that Cohen et al. (2011) found is that replicability within the qualitative research approach is limited to a constructivist view and thus abandons scientific methods and procedures of inquiry and investigation. Cohen et al. (2011) also noted that subjective methods implemented in the qualitative approach could cause the collection of wrong, inaccurate, and misleading data. For Eyisi (2016), not using numbers in the data collection process causes a situation in which qualitative researchers find it difficult, if not impossible, to simplify findings and observations. De Vaus (2014) stated that qualitative researchers believe that the social world of experiences of a participant has many dimensions, and that, therefore, explanations are limited to the interpretation of the researcher only.

The qualitative approach was of benefit to me in this study because it was conducted in naturalistic settings (see Thahn & Thahn, 2015). I selected participants and used sampling methods that resulted in rich data given that I was in close contact with the participants. I formulated my hypothesis after the data collection process had begun and modified it throughout the research study as I analysed the data.

4.3.3 Research design

A research design is a detailed description of the procedures that the researcher uses to investigate the phenomena under investigation (Asenahabi, 2019). Sileyew (2019) indicated that a very significant decision in the research design process is made that involves many interrelated ones. These include justification for the hypotheses and a detailed presentation of the research steps to be followed in collecting, choosing, and analysing data. Rahmi (2019) observed that qualitative research involves itself with inquiring that seeks to build a holistic, narrative based description to inform the researcher's understanding of a social or cultural phenomenon or perception and that qualitative research occurs in natural settings and involves a combination of observations, interviews, and document reviews.

Selecting a qualitative research design for this research study allowed me to collect the data that helped me make sense of participants' feelings, perspectives, motivations, and actions. Hennink and Kaiser (2022) stated that the number of participants in a qualitative research study guides the nuances, quality, and richness of the data. For this study, six participants were interviewed and observed while teaching in their classrooms.

Based on my choice of a qualitative research analysis, I chose to use thematic analysis, a qualitative exploratory research method that can be used across a range of epistemologies and research questions. For Braun and Clarke (2022), a thematic analysis is a method for identifying, analysing, organising, describing, and reporting themes found in a data set. Thematic analysis presents flexibility since modification can be implemented as needed in the research study, thus providing a rich, detailed, and complex account of the data. Thematic analysis is a useful method for determining the perspectives of different research participants in its highlighting similarities and differences, and generating unanticipated insights (Braun and Clarke, 2022).

I used empirical methods to collect data so as to yield objective and consistent findings (see Viorela, 2017). For Curnini and Franzese (2020), empirical methods have been equated with the use of quantitative measures (e.g, surveys) as well as primary collection and analysis of data. Nowadays, secondary analyses and qualitative research are also considered empirical. It seems plausible to

categorise qualitative research as empirical to the extent that scholars provide sufficient information to allow for the reproduction of their findings (Viorela, 2017). For this study, the use of a quantitative data collection method is for the intent to promulgate the intent of using a qualitative research approach.

Initially, I used questionnaires as the qualitative data collection technique since my intention was to guide the notes for the classroom observations and derive more intricate interview questions for participants' in-depth interviews. Subsequently, these two forms of data collection guided the formation of questions for the participants in the interview process that followed.

4.3.4 Research approach

There are various approaches to research. The selection of a research approach is dependent on what will best suit the method and intention regarding the collection of data. Creswell and Poth (2018) noted that there are five methods of approaching qualitative research: (a) narrative research, (b) phenomenology, (c) grounded theory, (d) ethnography, and (e) case studies.

A multiple case study design was used in this study; it is described as a research methodology that involves an in-depth analysis of several cases. This research design is used when we want to understand more than one case and we want to look at similarities and differences between and among cases. Hunziker & Blankenagel (2021) explained that with a multiple case study, we can conduct an in-depth analysis of several cases. First, an investigation of individual cases is conducted, and these studies are then combined. Some of the key characteristics of a multiple case include, firstly, that it involves an in-depth analysis of a small sample in its environmental context. In this study the sample was comprised of six teachers who were observed in the classrooms that constituted their environmental context. Secondly, contextual conditions were part of the research process. In this study I considered teachers from different school contexts that ranged from poorly resourced to well resourced. I also looked at schools that catered for mainstream learners as well as for those with disabilities. The cases also differed in terms of the language that was used most often in the classroom to mediate the content. Thirdly, the study was based on non-random sampling; I used purposive sampling in selecting the cases for observation and interview. Finally, a multiple case study focuses on differences and similarities between and among cases. The extent of the similarities in teachers' perceptions of, and approaches to, the problem of extensive language use in ML is explored in Chapter 12.

Within this paradigm a phenomenological approach was implemented in this research study. Creswell and Creswell (2018) indicated that phenomenology is a research approach in which one explores and tries to understand the specific meanings that individuals ascribe to a specific phenomenon. They indicated that this research method includes the inductive style of collecting data since this enables the collection of data, without preconceived categories, that includes the details of a participant's setting. Analyzing the data then generates aligned themes and the interpretation of these then results in the writing of a report on the findings. Creswell and Poth (2018) further supported the selection of this research approach because the exploratory verbs used for phenomenological research result in the participants' descriptions of the essence of their experiences. For this study a phenomenological approach involves several participants who have each experienced the phenomenon of interest, namely teachers' perceptions of language demands associated with the learning of ML.

4.4 Sampling of participants

Sampling in qualitative research is based on non-probability sampling. Unlike probability sampling used in quantitative research in which the researcher selects the population with characteristics that represent a wider community, in non-probability sampling in qualitative research the researchers select only specific populations to investigate a specific topic. I selected purposive sampling for this research study. As Lopez and Whitehead (2013) pointed out, in purposive sampling, participants are recruited according to a pre-selected criterion relevant to a research study's research questions, and, as Patton (2002) noted, purposive sampling is used in qualitative research for the identification and selection of an information-rich sample for generating an effective in-depth study with limited resources. Participants selected for the research study were, therefore, those who teach ML in their schools since they possess the specific knowledge necessary to provide the information required for the completion of the questionnaire. Cohen et al. (2011) observed that purposive sampling is based on the principle that the most relevant information for the research study will be obtained from a relatively small sample since, as Knott et al. (2022) pointed out, participants are selected with a specific purpose reflected in their characteristics, relevant experience, and expertise in the researched field. A further motive for the selection of purposive sampling is the interpretive nature inherent in it that is beneficial to the study.

Lopez and Whitehead (2013) stated that there are two types of sampling that form part of purposive sampling; these are quota sampling and maximum variation sampling. I used quota sampling to further define the parameters of this research study. In using quota sampling, the researcher decides

on the number of participants and on the characteristics they need to possess, such as age, gender, experience, and occupation. The inclusion parameters allow the researcher to recruit participants that would most likely possess the experience related to the research topic.

4.5 Data collection

4.5.1 Categorisation of participants

The Department of Education implemented the Quintile classification system to address the economic disparity of schools in South Africa by funding some schools more than others. The Quintile categorisation is measured by the average income, unemployment rates, and general literacy level in the school's geographic area (Ogbonnaya & Awuah, 2019). The schools that are most disadvantaged in socioeconomic terms are schools categorised as Quintiles 1 to 3. These are classified as non-fee-paying schools. Schools in Quintiles 4 and 5 are in economically advantaged geographical areas and are fee-paying schools. Of the thirty three participants, nine taught at Quintile 5 schools, seven at Quintile 4 schools, sixteen at Quintile 3 schools and one in a SEN school. However, it was noted by White and Van Dyk (2019) that the Quintile ranking system does not always capture accurately the extent of the poverty of the learner community. Thus, many schools ranked in the higher quintiles are actually resourced according to the lower quintile criterion. For this research study a Quintile 5 ranking indicates an affluent school that is well-resourced. Quintile 3 and 4 schools are under-resourced schools. Given the lack of government funding and the low fees generated in Quintile 4 schools (Western Cape Education Department, 2013), including the Quintile 4 categorised schools that were used in the study, it was observed that their lack of resources was like that of the Quintile 3 schools observed, thus the categorisation of Quintile 4 schools as under-resourced.

Of the 24 schools in the Umlazi and Pinetown Educational districts approached, 14 agreed to participate in the research study. These two districts were selected for this research study for their convenience of access by the researcher. 42 teachers were given a questionnaire to complete. Of the 42 teachers, 33 completed the questionnaire. Of these, nine were from well-resourced schools in the Umlazi Education District while one was from a SEN school in the Umlazi Education district and the remaining twenty-three participants were from under-resourced schools in the Pinetown and Umlazi Education Districts. These districts were selected as it was of the 33 participants, six of them volunteered to be observed and interviewed which constitutes the next phases of data collection. Of the six participants who were observed in the classroom, two were from well-resourced schools in

the Umlazi Education District, one was from a SEN school in the Umlazi Education district, and the remaining three were from under-resourced schools in the Pinetown and Umlazi Education Districts. The final stage of data collection involved these six participants.

4.5.2 Data collection strategies

For this research study, I used three methods for collecting data—observations, questionnaires, and in-depth interviews, all of which complemented each other and contributed to the triangulation of the evidence collected. As Heale and Forbes (2013) stated, triangulation benefits the researcher since the inherent strengths of different data collection methods are enhanced and helps to avoid potential biases inherent in the use of a singular method of data collection.

4.5.2.1 Questionnaires

A questionnaire was the first data collection method I used in this research study. The World Health Organisation (2001) defined a questionnaire as simply a list of mimeographed questions to be completed by or for a respondent to give his or her opinion. My questionnaire involved selecting a rating, combined with an open-ended question (see Appendix A). My objective was to collect rich and meaningful data that would, in turn, support the interview process through the creation of meaningful interview questions. The questionnaires also guided my classroom observation schedule and provided meaningful data towards answering the overarching research questions. I administered these questionnaires to the participants. The questionnaires were handed to participants by their Heads of Department during school hours, during which they completed them.

The implementation of questionnaires was the first of three phases of my data collection process. It determined how teachers perceive and respond to language demands associated with the learning of ML. The data collected during this phase supported the selection of participants for the subsequent two phases of data collection. These three categories of participants were labelled for my purposes, but as mentioned earlier, anonymity was observed. Participants were labelled alphabetically in the interests of anonymity according to the order in which the questionnaires were collected. Most of the data collected from the questionnaires was derived from a Likert scale and participants were given the opportunity to comment freely on these questions if they felt the need to do so and the remaining questions required written responses. The combined results obtained from the questionnaires led to the creation of themes that were used to improve and enrich the data collection strategies in phases two and three. In the questionnaire, there was space provided for the teachers' replies.

4.5.2.1(a) Advantages of questionnaires in research

If administered properly, questionnaires provide an excellent opportunity to obtain quantitative data about people's attitudes, values, experiences, and past behaviour (Bell 1999). According to McMillan and Schumacher (2010),

- Questionnaires are economical to administer.
- Questionnaires can be anonymous for the participant.
- Participants are asked similar questions [and] this provides reliability and validity.
- Questionnaires provide a high response rate as they are distributed to participants to complete and are personally collected by the researcher.
- Questionnaires give the participant the opportunity to think and reflect about their responses.

4.5.2.1(b) Disadvantages of questionnaires in research

I considered the weaknesses of questionnaires as one of my data collection techniques. For McMillan and Schumacher (2010),

- Questionnaires do not give the opportunity to probe or clarify the participants' responses.
- Questionnaires are generally used for the collection of quantitative data.

To mitigate these disadvantages, I conducted in-depth interviews to collect high-quality meaningful data. Bell (1999) also noted that consideration needs to be given to all aspects of the questionnaire, from the design to the selection of the correct target-group, in order to collect as much reliable and valuable data as possible. I implemented the triangulation of data collection methods to accommodate any possible limitations of the questionnaires to create meaningful and quality data for this research study.

4.5.2.1(c) Questionnaire design and piloting

Before a questionnaire is sent out to the participants, it should be pre-tested to ensure as far as possible accuracy and consistency in responses (Stockemer, 2019).

Roopa and Rani (2012) suggested that these pre-testing should be answered:

- Are the questions formed properly?
- Is the wording of the questions going to achieve the desired results?
- Have the questions been arranged in the best order?
- Is the wording of the questions easily understandable for the participants?
- Are additional or supplemental questions needed or do some questions need to be eliminated?
- Are the instructions clear and adequate?

The questionnaire was piloted by my using colleagues to ensure clarity and the likely achievement of my objectives.

4.5.2.2 Observations

Observation was the second method I used to collect data for this research study. According to McMillian and Schumacher (2010), observation as a technique for gathering data, depends on the researcher's observational skills and ability to record these observations, rather than on participants' self-report responses to questions or statements. Schensul et al. (1999) indicated that observations help the researcher to form a guiding relationship with the participants in a research study. This relationship guides the researcher in her or his interactions with participants and helps to determine appropriate questioning during the in-depth interviews that will best help to answer the research questions. Kawulich (2012) indicated that direct observation helps the researcher to understand the participants' world. This is achieved by the researcher observing participants but not getting involved in their activities, in this case, in the classroom. Giving the researcher the opportunity to write down all that is observed in real time allows for more accurate data.

For this research study I adopted an overt observation stance. Kawulich (2012) noted that overt observations take place when participants are aware of being observed and when the researcher is open and honest about this. I also informed the learners in the class that the participant teacher was being observed. Observation allows for sensitivity in cases where in-depth interviews could be considered impolite or insensitive (Mesman, 2021). I formulated an observation schedule to guide and direct this goal-oriented data collection process. Speed (2019) noted that if the researcher knows which behaviours to observe in a classroom, an observation schedule can be used to categorise and classify the observed behaviours. Thus, the observations schedule directed the observation to certain

behaviours and features during the observations that is pertinent to the study's objectives. My observation schedule consisted of two stages (see Table 4.1).

Table 4.1

Observation schedule.

Observation schedule	
1. The learners	a) Observations will focus on how the learners give verbal feedback to the teacher. What language is used? How elaborate is the feedback? Is the correct mathematical language used? Does the learners' feedback use correct mathematical terms?
	b) Work completed by learners to be viewed to observe if they understand the concepts taught. This evidence will be collected to create meaningful interview questions.
	c) Observe the behaviour of learners throughout the lesson. Are they engaged and do they display understanding of instructions and mathematical concepts?
2. The teachers	a) Observe how the teacher communicates with the learners. Does the teacher use code switching and correct mathematical language?
	b) What is the teacher's teaching strategy? How much time is given to assess learners' performance. Is group work used?
	c) Does the teacher effectively monitor the learners' progress throughout the lesson to address any barrier to learning effectively and in a timely manner?
	Observation of teacher monitoring of learners will focus on: i) Does the teacher observe mathematics performance only? ii) Does the teacher address only numbers? iii) Does the teacher address mistakes made because of a failure to understand the language in ML?

4.5.2.2(a) Advantages of observation in research

McMillian and Schumacher (2010) noted that using observation limits the possibility of self-report bias and of researcher's social bias. Also, information is not limited to what can be recalled accurately by the participants. What happens in real-life is recorded, as opposed to what happens in highly contrived and artificial settings. For me, selecting observation in this research study was to determine what actually occurs in the classroom to assist me in answering the research questions. I recorded data about the classroom environment and about the participants' behaviour instantly without having to rely on retrospection or on accounts of others (see Bostic et al. 2020).

Observation enables the researcher to observe what participants cannot see. This can be important information regarding features of the classroom environment and behaviour that is taken for granted by the participants and not likely to appear in questionnaire replies or in-depth interviews. These advantages give rise to the opportunity to collect rich, detailed descriptions of the classroom setting, improve interpretation, and develop new questions to be asked of informants (DeMunck and Sobo, 1998).

4.5.2.2(b) Disadvantages of observation in research

There are several disadvantages or limitations to using observation as a method of collecting data. Observers may, consciously or unconsciously, change the way they conduct themselves because they are being observed so observational accounts of their behaviour may be inaccurate representations of how they behave when unobserved. Another disadvantage of observation is that the observation is administered by the researcher who will view the observations through his or her "specific research lens" (Holmes, 2020, p. 6). Therefore, emphasis must be placed on the fact that observation cannot necessarily provide a direct representation of reality.

DeMunck and Sobo (1998) suggested that the degree to which the observer is accepted by the participant is determined, in part, by how well he or she is perceived by the participant. This acceptance may be based on gender, age, class, ethnicity, and even appearance. Acceptance is based on whether participants trust and feel comfortable with the observer (Schensul et al. 1999). Florczak (2022) emphasised that researcher bias can have an adverse effect on the data collected during observation. There has to be an acknowledgment of the observer's own biases and she or he has to set aside these biases, view the data neutrally, and make accurate interpretations. The observer will need to consider potential biases that have developed from her or his personal background and experience based on gender, culture, and ideologies that provide a filter for the understanding of the situation under study. Kawulich (2012) reminded us that the quality and contribution of the

observations is determined by the observer's ability to describe what is observed accurately and in detail.

4.5.2.3 In-depth interviews

The third data collection instrument I selected for this research study was in-depth interviews and as Morris (2015) noted, this is the most common qualitative research method and added that in-depth interviews involve a researcher asking questions and following up on the responses of the participant in an attempt to extract as much information as possible from the participant who has expertise on the topic/s in which the researcher is interested in. Hofisi et al. (2014) said that in-depth interviews on the personal experiences and perspectives of participants are crucial for data collection. For Knott et al. (2022), the in-depth interview, ideally conducted in a relaxed, open, and transparent setting, is a human interaction that consists of two individuals discussing a topic. Rutledge and Hogg (2020) stated that in-depth interviews are valuable because they allow researchers to explore the subjective viewpoints of the participants and gather in-depth accounts of their experiences. Gubrium and Holstein (2015) noted that the interview can be regarded as a device for inciting narrative production. In-depth interviews are conducted conversationally with one participant at a time and consist of open-ended questions that are often supported by follow-up questions to further the understanding of the topic at hand. Adams (2015) stated that the dialogue can meander around the topics on the agenda rather than adhering verbatim to a set of questions in a standardised list of interview questions and may delve into totally unforeseen issues. The in-depth interview questions I asked participants were meant to lead me to an understanding of their thought processing regarding the research questions of my research study. The interviews were semi-structured since this allowed me to allocate specific questions to specific participants based on what I had observed in their classrooms and on the feedback I was given by the participants in the questionnaires. The interviews were conducted one-on-one, at a place of the participants' convenience and took between 30 to 50 minutes. There were certain questions that were standard for all participants, like, for example, "Do you enjoy teaching at your school?", "What training have you had in teaching and in teaching ML?" and "Do you know how many languages are spoken in your class?" (see Appendix B).

4.5.2.3(a) Advantages of in-depth interviews

Within the spectrum of possible models of interviews, there are two extreme approaches. In one, all participants in a research study are asked a standard set of pre-planned questions in the same order,

and responses are noted without any additional probing for supplementary information. In the other, the interviewer begins with a single question. The rest of the interview becomes a dialogue based on spontaneous questions raised by the interviewer based, in turn, on answers to previous questions. I used both approaches to create a comfortable environment for the participant so that I could elicit accurate and informative data for this research study.

Pre-planned questions give the interviewer the opportunity to cover all topics that need to be explored in the interview and to elicit additional data the participant may not have disclosed. This then allows the interviewer to ask unplanned questions to gather further relevant data from the participant.

Morris (2015) indicated that an in-depth interview

- Gives access to rich personal data;
- Gives the opportunity to understand an individual's context and motivations;
- Follow[s] up and probe[s] the responses and examination[s] of complexity;
- Allows the interviewee to talk about what they think is important;
- Is an extremely versatile method;
- [Allows for] non -verbal information [to] be obtained from observing body language and intonation (p. 7).

4.5.2.3(b) Disadvantages of in-depth interviews

Hofisi et al. (2014) indicated that in-depth interviews display several weaknesses; their flexibility may imply that they are not reliable and that they require a very highly skilled interviewer to ensure reliability. They also noted that the in-depth subjectivity of interviews may cause participants to respond with feedback the interviewer wants to hear, rather than with accurate information. This will have an impact on the validity and reliability of the data collected during the interview. Open-ended questions in the interview can elicit irrelevant data. Hofisi et al. (2014) noted that the chances of researcher bias and misunderstanding cannot be ruled out during the interview process.

Morris (2015) listed the following weaknesses of in-depth interviews.

- Interviewee could be presenting inaccurate information;
- Impossible to draw a random sample of interviewees;
- Data obtained cannot be generalised to the population;
- Large amount of time and effort required to set up interviews;
- Potentially expensive; transcribing is costly;
- Transcribing is time-consuming (p. 7).

4.6 Data collection procedure

4.6.1 Reasons for selection of the instruments

The objective in using the research instruments in this order was to obtain the required information at the correct time in the data collection process. The questionnaires provided the necessary preliminary information for me to ascertain which participants would provide data that would be rich and relevant. Following this, the classroom observations provided the opportunity to gain further understanding of the participants' understanding of the research questions and gave me the opportunity to create questions for the interview that would have substance and be relevant and valuable to the research study. All classroom observations were done by myself. I met with the teachers beforehand and explained the purpose of the observations to ensure that they felt comfortable and at ease. The in-depth interviews gave me the opportunity to ask the participants probing questions to gather rich and valuable data. They provided participants with clarity and gave them a platform from which they could offer their opinions and feelings about the study's objectives. It provided some sense of conclusion to the study.

4.6.2 Questionnaires

The questionnaires were distributed to 43 participants from 14 schools. They were given a week to complete them either at their respective schools or at home. I then collected them.

4.6.3 Observations

After the analysis of the questionnaires six participants gave me permission to observe and interview them. One was from a SEN school, two were from well-resourced schools, and three were from under-resourced schools. The six participants were contacted, and convenient dates and times were arranged to accommodate their being observed in their classrooms. They were informed before the observations that there was no expectation to conduct themselves any differently than they would have done under usual circumstances. The observations were conducted with the intention of creating the least amount of disruption to the participants and the learners in the observed lessons. I conducted the signing of the learner consent forms before the lessons had begun. I recorded the observations in several forms for the different participants. Of the participants, four were video-recorded and the observed lessons were transcribed. One participant was audio recorded and the observed lesson was transcribed. The last participant chose not to be recorded so I wrote notes to describe the observation. In all observed lessons or parts of observed lessons where the medium of instruction used was isiZulu, I used an interpreter to transcribe those parts of the lessons.

4.6.4 In-depth interviews

After I had analysed all the questionnaires and the lesson observations for each of the six participants. I contacted each participant via email to confirm a convenient date and time for an in-depth interview. All interviews were recorded using two audio recording devices and were transcribed later.

4.7 Validity and credibility of research instruments

4.7.1 Validity

For Zegwaard et al. (2017) to obtain a high degree of validity in a research study it is necessary to conduct a three-step content interval validity process: determining content domain; sampling from content (item generation); and instrument construction. Content domain is identifiable through an extensive literature review (see Chapters 2 and 3) on the topic being investigated and on interviewing the respondents (see Chapters 6 to 11). The second step in instrument design is to study the research findings and reflect on the relevance of the research questions of the study. In the third step, the data collection instruments are organized in a sequence to collect data that are valuable and usable (see section 4.6).

Cohen et al. (2011) indicated that external validity determines the extent to which the research study's findings can be generalised beyond the parameters of the sample used in the study. Since this study had a number of teacher participants from schools ranging from under-resourced to very well-resourced its research findings can be generalised to schools in South Africa and beyond its borders.

4.7.2 Credibility

Lincoln and Guba (1985) defined credibility as confidence in the truth of the research findings. For Korstjens and Moser (2018), credibility is based whether the research findings represent plausible information drawn from the participants' original data and interpret correctly the participants' original views. They indicated that strategies to increase credibility are prolonged engagement, persistent observation, triangulation, and member check. (See Table 4.2.)

Table 4.2

Definition of strategies to ensure trustworthiness in qualitative research. Based on Lincoln and Guba (1985).

Strategy	Definition
Prolonged engagement	I observed and conducted interviews with participants that involved a long-lasting engagement. Each interview was between 30 and 60 minutes and each participant was observed for one or two lessons depending on the progress that was made in the first observation. This gave participants a sense of familiarity with the setting, and allowed me to test for misinformation, build trust, and to familiarise myself with the data collected to ensure its richness.
Persistent observation	This allowed me to identify and obtain characteristics and elements that were most relevant to my research questions in this study.
Triangulation	I used different data sources and methods of data collection. Time triangulation refers to gathering data at different times of the day. Participants were given the choice of when and where to complete the questionnaire. Each participant chose a class to be observed at a time of their choosing so these were conducted at various times of the school day. The

	interview was conducted at a place and time according to each participant's choice. • Space triangulation refers to collecting data on the same phenomenon in different sites, so I observed six teachers in classrooms in five different schools. • Method triangulation refers to using many methods of data collection. In this research study I used questionnaires, observation, and in-depth interviews.
Member check	Obtaining feedback from participants on the data as they are gathered is essential since this ensures credibility. Also, this practice increases the validity of the data because researcher and participants look at the data from different perspectives.

4.8 Ethical considerations

I based the ethical considerations for this research study on a set of principles that guided it and its data collecting design. Fleming and Zegaard (2018) commented on the importance of selecting appropriate research methodologies and methods for research studies given the significance of the ethical considerations involved. Arifin (2018) noted that qualitative research studies have a particular resonance because of the in-depth nature of the data collection process.

4.8.1 Ethical Expectations

Zegwaard et al. (2017) stated that it is the responsibility of the researcher to engage in responsible and ethical data collection. It is the researcher's responsibility to keep participants safe during this process and to safeguard their dignity and rights. Further to this, as Chun (2017) noted, in all stages of the data collection process there are ethical issues to consider. The participants must be informed of their rights and their role in the research process. They must be made aware that they are entitled to withdraw from the research study at any stage. (See the consent form in Appendices E, F, G)

4.8.2 Informed Consent

Fleming & Zegwaard (2018) indicated that it is imperative for participants to provide explicit, active, signed consent to participate in a data collection process. This includes participants' understanding their rights to the access of their data and, as mentioned above, that they can

withdraw from the data collection process at any time. This informed consent process can be seen as the contract between researcher and the participants.

Participants need to know (see Appendix F):

- Who the researcher(s) is (are);
- What the intent of the research is;
- What data will be collected from them;
- How the data will be collected from them;
- What level of commitment is required from them;
- How this data will be used and reported; and
- What the potential risks of taking part in the research are (Fleming & Zegwaard, 2018).

They are important for the consent form to be clear, credible, and well written. Ambiguity in it will result in a weak consent agreement. This can compromise the quality of the data collected because of mistrust (Tamlyn et al. 2023) and provides poor protection for the participants. The informed consent letter was presented to participants before the data was collected. This came in a form of two pages based on Fleming and Zegwaard (2018) elaboration on the aspects of consent (see Appendices E, F, G):

- ‘opt in’ rather than ‘opt out’ approach (i.e., active consent instead of passive consent since the latter remains highly contentious),
- information on the right to withdraw at any at any time without reason (including withdrawing data already provided),
- assurances that participant identity will be kept confidential,
- their right to access to their data,
- the right to ask for more information.

4.8.3 Conflict of Interest

I used participants with whom I had a relationship in the initial processes of data collection but, following Fleming and Zegwaard (2018), to avoid any possibility of a conflict of interest I

conducted the final and critical processes in the data collection—the classroom observations and the interviews—with participants with whom I had no previous relationship.

4.9 Development of the research questions

The research questions were developed before the collection of data, however, I adapted the first research question (What are teachers' perceptions of the learners' struggles with the language complexity in ML?) to correlate with the themes that arose from the collected data. The second research question (How do teachers support the learners in addressing the language demands and complexity in ML?) arose from my awareness of participants' concerns given their earlier responses. The third research question (What are teachers' suggestions on how they could be more effectively supported in teaching ML?) was derived from the participants in relation to a concern that they voiced without being in any way prompted by me.

4.10 Data analysis and feedback to participants

4.10.1 Analysing qualitative data

Given the use of qualitative data collection techniques, participants submitted data that led to rich themes for analysis. Tracy (2019) reminded us that researchers must let go of any preconceived notions or assumptions about participants and must not assume that specific data will emerge. As she noted, “things aren't always what they seem” (p. 43) so research may challenge or alter expected assumptions. I conducted the analysis of the data in three stages. I analysed the responses to the questionnaires (see Chapter 5) and this guided me towards implementing more meaningful classroom observations and towards formulating thought provoking questions for the in-depth interviews. During the second stage of the data collection (observing the participants in their classroom) I created personal tailored questions for the following in-depth interview to produce rich and detailed data for the study. This triangulation of data collection, as Lemon and Hayes (2020) noted, was in the interests of the credibility of the data collected from which I then derived the themes.

I synthesised the data from the questionnaires, lesson observations, and in-depth interviews into a narrative account of each participant to whom I have dedicated a chapter I named according to their personal disposition in conveying empathy towards the learners as they tried to support them to deal with the language complexities in ML. McMillan and Schumacher (2010) noted that the framing of

the narrative is fundamental to creating a clearer understanding of the findings for future research. I used the synthesised narratives to address the research questions for this research study (see Chapter 12). In this study there are multiple layers of analysis. Firstly, the written responses to the questionnaires were analysed and used as a basis for the purposive selection of the six participants whose ways of teaching would then constitute the six cases studies. The second layer of analysis was the weaving together of the vignettes of each of the six cases presented in Chapters 6 to 11. Cruzes et al. (2015) referred to this process as a narrative analysis in which data sources are woven together to derive a story of each participant. These vignettes allowed me to emphasise what motivated the individual teachers and how they mediated the ML content and tasks with their learners in response to the language demands they perceived. The vignettes allowed me to arrange and display the data for analysis and set the stage for the third layer of analysis which was the actual cross case analysis of each case. Cross-case analysis is a powerful tool in multiple case study design since it allows researchers to draw robust conclusions and extend theories based on the comparative analysis of different cases. A cross-case analysis reveals similarities and differences and how they impact on findings, and this is presented in Chapter 12 as part of my overall response to how I answer the research question.

I analysed the data using the Cummins's (1994) 4QCCDF (p. 41, adapted). I presented the data on a continuum figure to illustrate what each participant's perception is of the learners' struggles with the language complexity in ML. This answered the research question regarding the teachers' perceptions of the learners' struggles with the language complexities in ML. The placement of the participants pictorially on this model emphasised the response of each participant regarding the language demands associated with the learning of ML (see Chapter 12).

4.10.2 Feedback to respondents

I emailed the data to the participants and to their respective school leadership, thus providing the evidence I had collected.

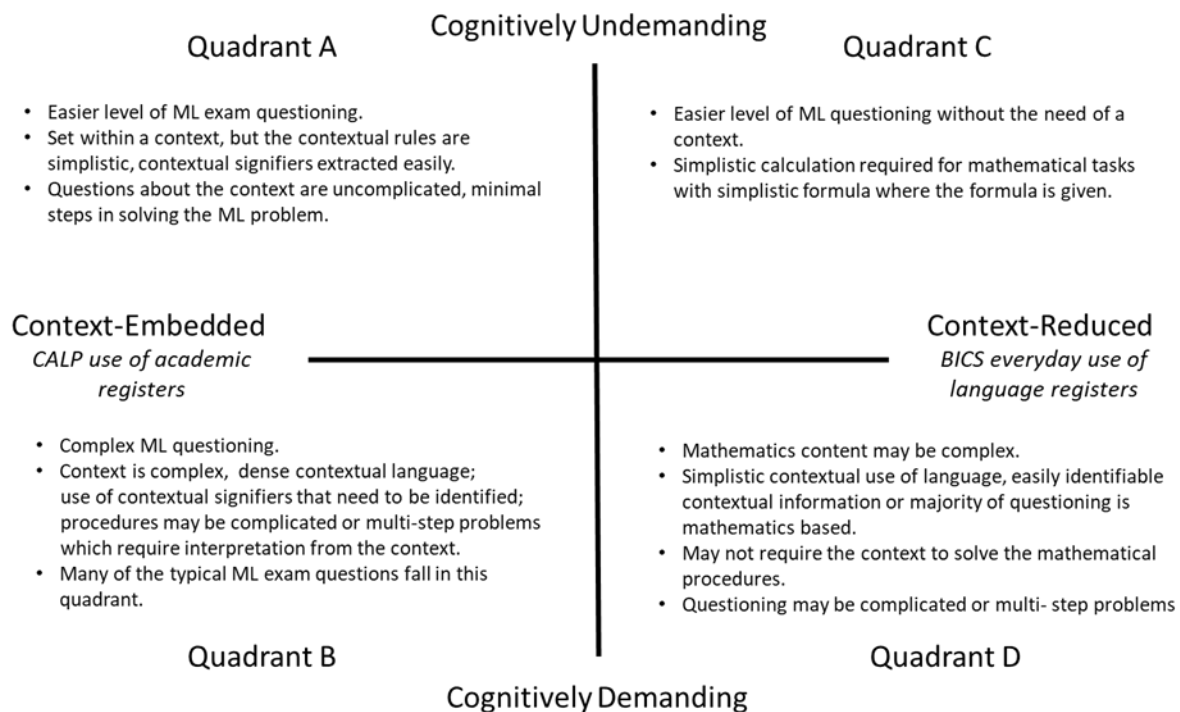
4.10.3 Analysis of the data using the Cummins Framework.

Cummins's adapted Four-Quadrant Contextual and Cognitive Demands Model (1994) was used in this study to categorise the ML tasks according to the quadrant of learning that takes place in participants' classrooms. The model takes contextual language changes for each task or setting in ML into consideration. For this study, I use the framework to depict the various kinds of ML tasks

that teachers mediate in their classrooms. For the purposes of my research study, tasks in Quadrant A and B are strongly bound to the context and require CALP in the use of contextual registers. Quadrant A and B tasks require learners to process information based on the contextual support where the context may be complex, with dense contextual language and may draw upon the identification of contextual signifiers. For these tasks, the teacher could model the language learners need to classify the objects and prompt them to make pertinent observations and pick out the necessary contextual information. Learners may be asked to describe their findings, while using the correct terminology and language (guided by the teacher). While tasks in quadrant A are those which may be cognitively undemanding, those located in quadrant B are those that are more cognitively demanding. Hence the Quadrant B tasks are the typical of those which appear in the second examination paper for ML, which are based on an extended context and require complex calculations.

Figure 4.1

Criteria used to classify tasks in the 4QCCDF model



In quadrants C and D, the tasks may be context-free or may draw superficially on a context, but they differ according to the cognitive demand. Quadrant C tasks have less contextual support but do not

involve learners in too much information processing like, for example, copying information from a text and completing simple mathematical tasks that are not context based. In Quadrant D, tasks require learners to display the mastering of academic functions (Cummins, 2000), so Quadrant D consists of tasks that have minimal familiarity of context for the learners and require a high level of cognitive demand. In this quadrant, learners are required to interpret the meaning of statistics or graphical information and carry out multi-step procedures or compare answers and make judgements about the results and analyse critically at a high level of academic language.

Based on the previous descriptions, here is the summary of the criteria used to classify the tasks according to the quadrants for the participants (see Chapter 12.4.7 and Figure 4.1).

4.11 Storage of data and disposal of data

Following the rules and regulations of the University of KwaZulu-Natal, this data will be kept for a period of five years after which time it will be destroyed.

4.12 Conclusion

In this chapter I discussed the research methodology I used in this research study. I outlined and discussed the constructivist paradigm that guided the study along with my qualitative research method. I explained that my chosen methods of collecting data and my nuanced and comprehensive understandings of data promoted the elaboration of the participants' perspectives. I outlined the research study's design and, following the ethical considerations, discussed the data collection instruments in relation to their advantages and disadvantages. I addressed the issues of validity and credibility. I concluded the chapter with a description of how the data was analysed, how the findings were fed back to the participants, and pointed out the rules governing data storage at the University of KwaZulu-Natal.

Chapter 5: Questionnaire

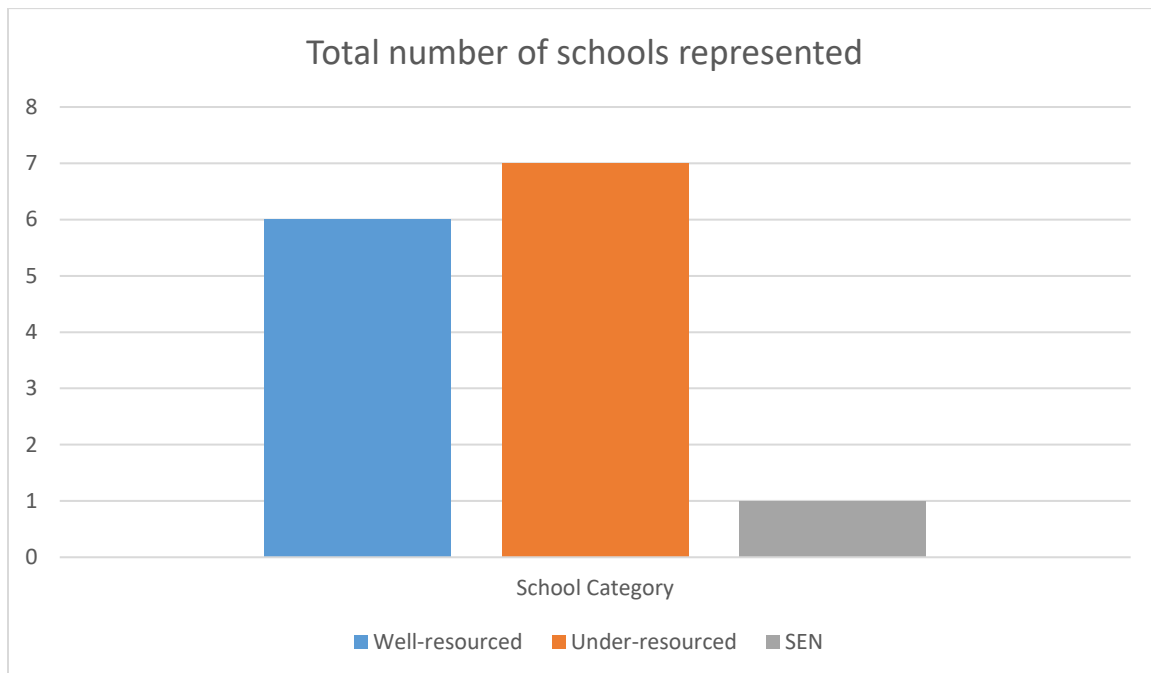
5.1 Introduction

5.1.1 Categorisation of participants

Participants were categorised by the schools at which they were employed. My motivation here was based on the fact that in South Africa there is a wide economic disparity between the rich and the poor as Spaul (2015) has reminded us. This disparity contributes to unequal education opportunities for learners from different socioeconomic backgrounds (Graven, 2014) and this is reflected in the Quintile classification system implemented by The Department of Education as explained in the previous chapter. The Quintile categorisation is based on the socioeconomic status of a school, and is measured by the average income, unemployment rates, and general literacy level in the school's geographic area (Ogbonnaya & Awuah, 2019).

Graph 5.1

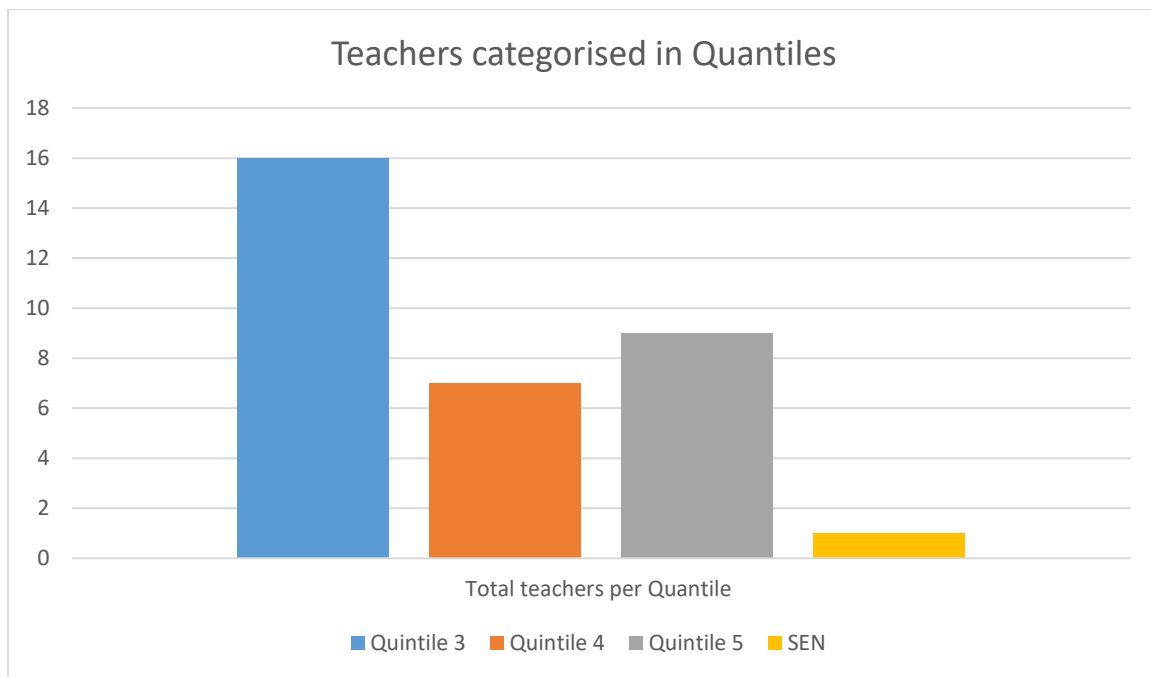
Total number of schools represented in this study.



There were 14 schools that participated in this research study. Of these, three were categorised Quintile 5, three as Quintile 4, seven as Quintile 3 and one school as a SEN school (see Graph 5.1). Nine participants came from Quintile 5 schools, twenty-three from Quintile 3 and 4 schools and one from a SEN school (see Graph 5.2).

Graph 5.2

Total number of participants categorised for this study.



5.2 Teacher information

It was crucial to gather information from the 33 teachers including their experience of teaching ML and how their experience and qualification levels influence their confidence in, and approach to, teaching ML in the classroom.

5.2.1 Gender

Of the 42 teacher participants who were given questionnaires to complete, 33 completed them; the following is based on these responses. In the SEN school there was one woman and in the under-resourced schools, there were seventeen men and nine women teachers. It is interesting to note the gender disparity when it comes to well-resourced and under-resourced schools since in the former

there is strong female representation and in the latter strong male representation. No attempt was made to balance the gender of participants because participation was voluntary.

5.2.2 Years of teaching experience

The 33 participants had an average of 12.3 years of teaching and 6.23 years of teaching ML. There were three very experienced teachers in the well-resourced schools, having 20, 25, and 26 years respectively of teaching experience. The under-resourced schools also had four very experienced teachers with 32, 32, 27, and 23 years respectively of teaching experience. For Podolsky et al. (2019), learners benefit more in the classroom from more experienced teachers who offer numerous benefits to their learners and to their schools.

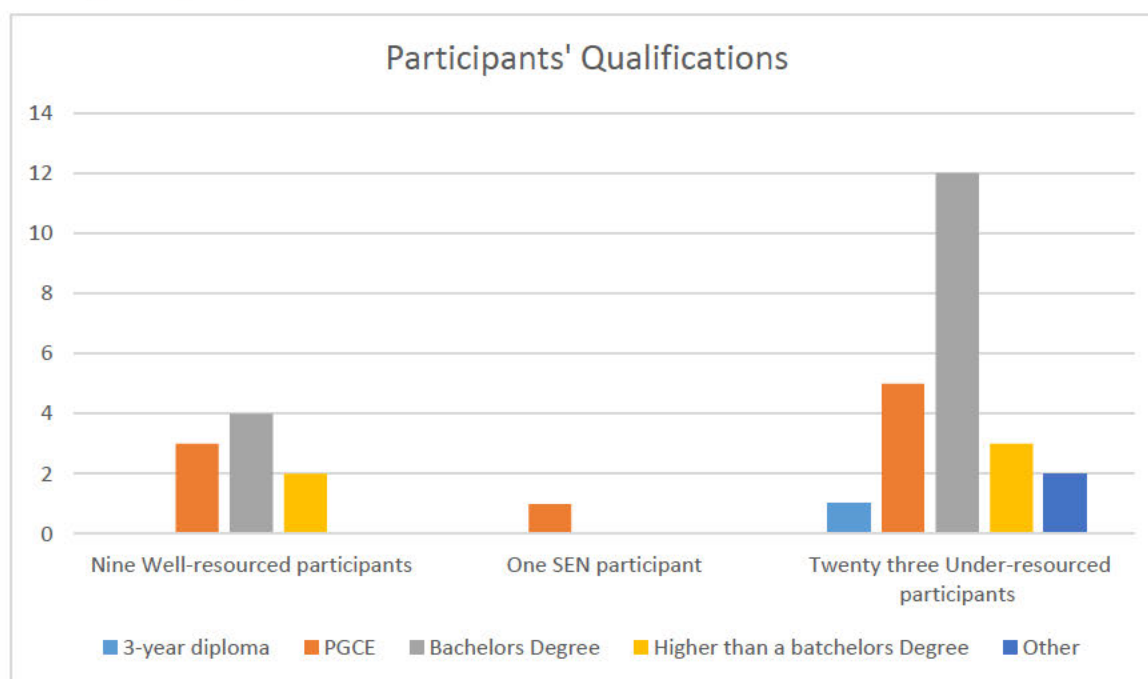
5.2.3 Teacher's qualifications

All participants answered the question regarding their qualification with some having more than one qualification, with a total of 49 qualifications among them. One participant with a three-year diploma also had an honours degree. Among them, participants had 10 PGCEs, 26 Bachelor's degrees, five had a degree higher than a Bachelor's degree, and there were 7 participants who had other degrees (see Graph 5.3).

The distribution of qualifications of the participants is closely dispersed with minimal disparities so all learners in the participants' classrooms were taught by teachers with close to similar qualifications. Bhai and Horoi (2019) noted that findings that are related to a teacher's higher qualifications in correlation to learners' achievement in the classroom are inconclusive. There are some studies that display evidence of a positive effect such as (Abe & Adu, 2014) but other research shows either no or negative effects (Musau & Migosi, 2015). Similar research conducted in South Africa by Mji and Makgato (2006) determined that it is not the qualifications of teachers that predict the outcomes of learners but is, rather, the teaching strategies selected, the content knowledge, and the motivation that affect learners' achievements. Also, non-completion of the year's syllabus in an academic year influences these. This will be reflected in the observations of the participants.

Graph 5.3

Participants' Qualifications.



5.3 English proficiency and Mathematical Literacy

This section of questions in the questionnaire sought participants' perceptions and views regarding the role English plays in the ML classroom. Since teachers were also given the opportunity to comment, these comments appear below. The questions posed to the participants determined how they felt, from a personal point of view, about the extent to which English proficiency influences their teaching in the ML classroom and how the learners' English proficiency influences their learning.

5.3.1 The home language of learners

Participants were asked if most of their ML learners spoke English as a home language. The participants' views were derived from questions that participants could answer by selecting options from a five- scale choice: 1. Strongly disagree; 2. Disagree; 3. Neutral; 4. Agree; 5. Strongly agree. The under-resourced schools' participants and the SEN participant all strongly disagreed or disagreed except for one participant who was neutral (see Table 5.1 and Graph 5.4). The responses of the participants generated four themes. First, two participants indicated that half their class speaks English as a first language at home. Second, thirteen participants indicated that most of the learners

in their classes speak English as a second language. Third, two participants indicated that their classes consist of learners who speak a diverse range of languages in one classroom. Fourth, four participants

Graph 5.4

The home language of the majority of the learners in my school is English.

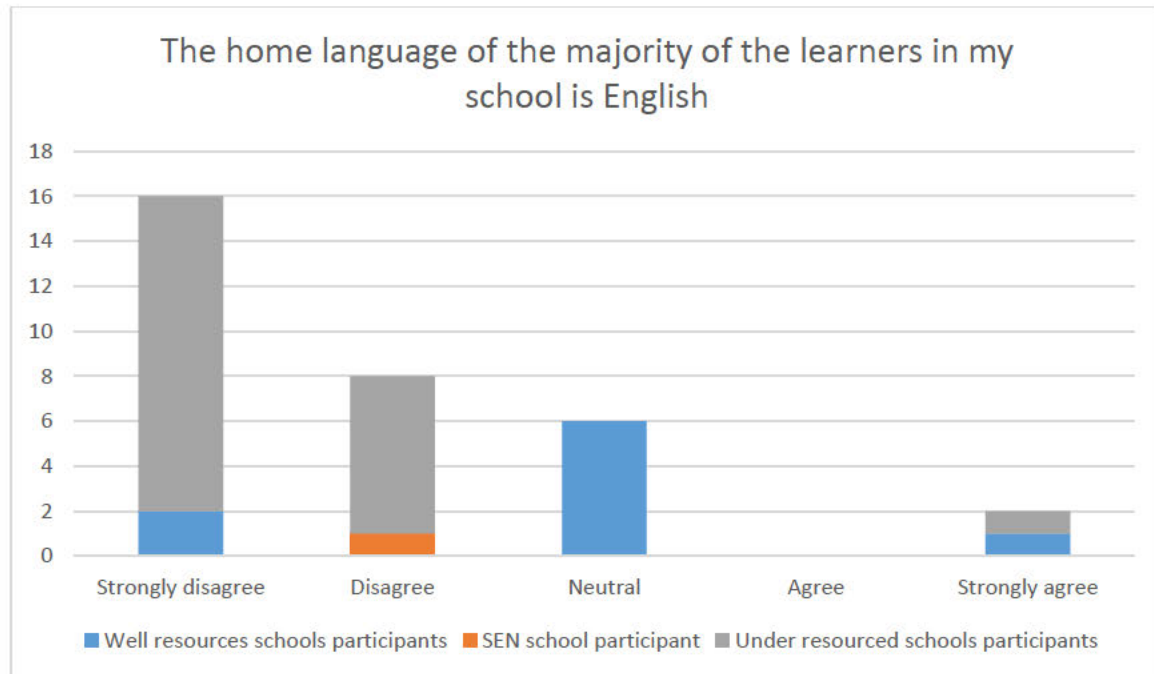


Table 5.1³

Question: The home language of the majority of the learners in my school is English.

	1	2	3	4	5
Combined	50%	25%	18.8%	0%	6.25%
Well-resourced	22.3%	0%	66.7%	0%	11.1%
SEN	0%	100%	0%	0%	0%
Under-resourced	63.6%	31.8%	0%	0%	4.54%

indicated that none of the learners in their classes speak English as a home language. (South African research supports this since, as Statistics South Africa (2018) indicated, only 20.3% of South

³ All tables are responses to the Likert scale questions in the questionnaires

African citizens speak either English or Afrikaans as a Language of Learning and Teaching in their households.)

5.3.2 Disadvantages in not being able to speak English as a first language

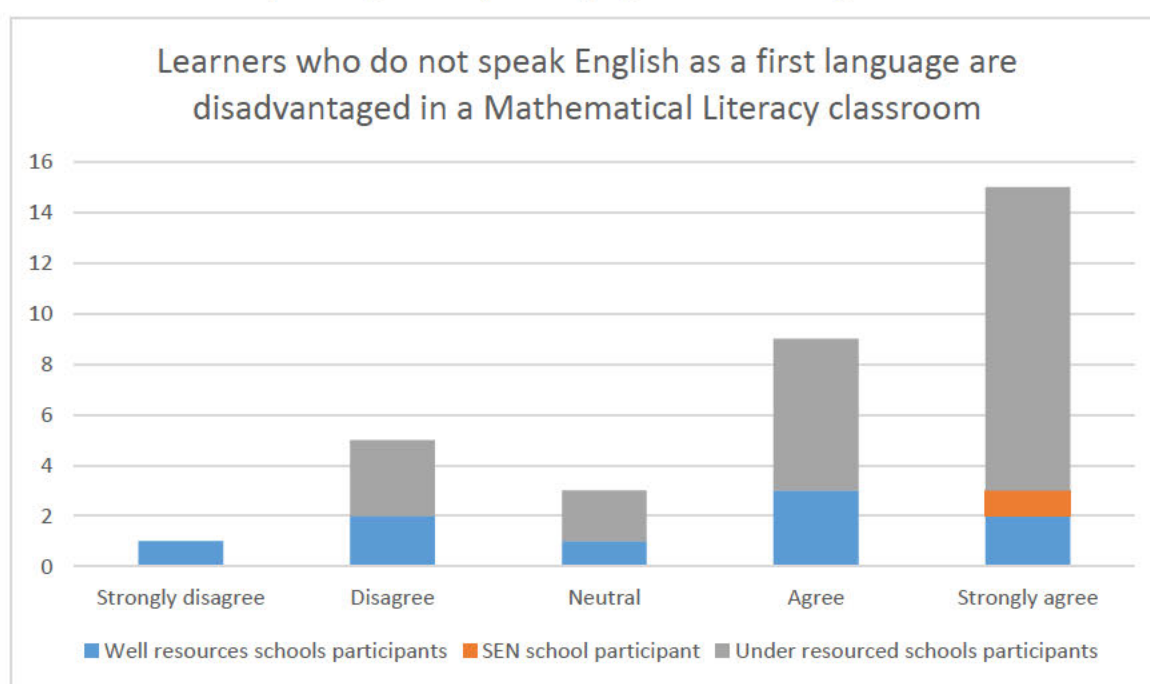
Participants were questioned about English language proficiency in the classroom to determine their views on the influence English proficiency has on their own teaching practices, on learners' operations in the classroom, and on the degree of learner disadvantage in tests and examinations if they do not speak English as a first language. Teachers were also given the opportunity to comment on each question and these comments are described below. Replies to these three questions gave me an understanding of the influence that language has on participants in their ML classrooms.

Participants were asked if learners who do not speak English as a first language are disadvantaged in a ML classroom. The results were polarised for all categories of participants. As an outlier, one participant strongly disagreed with this suggestion (see Table 5.2). Of the participants, 21 responded in the comments section of this question. Most of the participants agreed with the statement (see Graph 5.5). Four themes were generated from the participants' comments. First, two participants disagreed with the statement. Participant F stated, "I have had [second] language English learners [who] have scored 95% for ML in grade 12." Secondly, two participants indicated that contextual interpretation is a barrier to achieving in ML. Participant X said that "the only problem we have is that the context differs because learner[s] from urban and rural areas. . . don't interpret problems in the same way." (The literature supports this; Latu (2005) and Padula et al. (2001) noted that cultural influences can affect how learners read in the ML classroom.) Third, six participants partially agreed with the statement with Participant T saying, "Language is not a problem. The problem is interpreting the message in the problem." Participant P further supported this statement by indicating that learners take time to sense the meaning of the problem and participant Q also indicated that "learners understood most parts of the scenarios in ML." (The literature supports these participants' opinions; Jourdain and Sharma (2016) stated that learners who do speak English as a home language have to contend not only with the vocabulary and register of mathematics, but also with the changes in meaning between registers.) Fourth, 10 participants agreed with the statement by indicating that, as participant W stated, "This above statement is one of the main contribut[ions] [to] learners failing ML." Participant I agreed with participant W and said, "[Second] language learners struggle with grammatical contexts of questions and minor nuances in the language that change[s] the emphasis of the question." For Participant R, "They are not able to interpret or understand questions [about] what is actually needed." Participant V said, "Terminology

used is one of the biggest problems [for] our learners [because] most of the problems are scenarios that learners need to understand before they answer.” Participant L agreed, “Sometimes it is very hard for learners to understand English and they [do] not speak English as their home language.” Because of this, Participant O said that teachers use code switching to support learners in understanding the context of ML questions. Two participants pointed out that there is a correlation between learners’ English proficiency and ML marks. Participant AH said, “ML and English are

Graph 5.5

Learners who do not speak English as a first language are disadvantaged in a ML classroom.



twins. You cannot have ML without English. [B]y the way, ML needs learners to understand English.” (The literature supports this belief; Predeger et al. (2019) identified that language gaps are of concern for multilinguals and monolinguals who are fluent in everyday language use. Lin (2016) noted that since language differs according to its context, learners need to develop language proficiencies appropriate for use in the mathematics classroom.)

Table 5.2

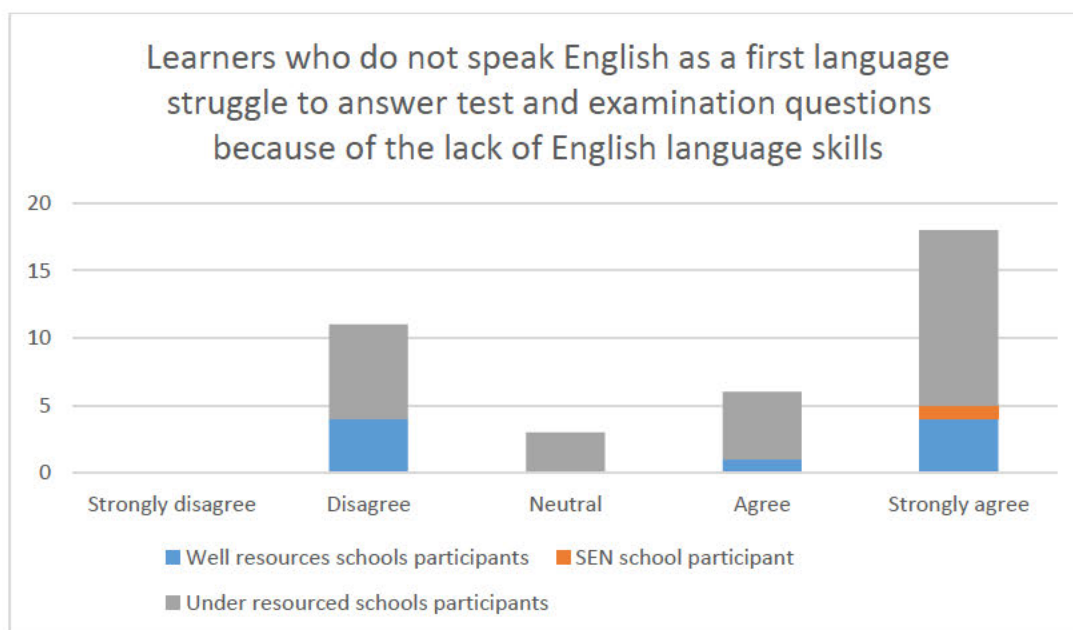
Question: Learners who do not speak English as a first language are disadvantaged in a ML classroom.

	1	2	3	4	5
Combined	3.03%	15.2%	9.09%	27.3%	45.5%
Well-resourced	11.1%	22.2%	11.1%	33.3%	22.2%
SEN	0%	0%	0%	0%	100%
Under-resourced	0%	13%	8.70%	26.1%	52.2%

The following question follows on from the previous one in determining participants' views of learners who, in not speaking English as a first language, struggle to answer test and examination questions. Most of the participants agreed with the statement; 72.7% agreed or strongly agreed (see Table 5.3 and see Graph 5.6). Of these participants, 15 responded to the comments section of this question giving rise to four themes. First, four participants indicated that language has some, if minimal, effect in the examination and assessment results in ML. Participant Q stated, "The language has some effect on how learners answer questions." Participant T agreed in saying, "That may be true, but it wouldn't make any difference even if they were taught in their home language." Second, two participants indicated that there is a two-fold problem in that learners need to possess English proficiency and they need to master mathematics as a language, too, in order to succeed at ML. Participant O stated, "Instructions are written in English and English is the language of learning and teaching. So, learners find it hard to understand some concepts while. . . mathematical language need[s] understanding as well. So, it is a double job for them." Third, seven participants indicated that it is essential to gain English proficiency to interpret content and read questions correctly. Participant I said, in agreement with this, "Misunderstandings and poor interpretation of questions is [a] contributing factor to poor performance." Participant A further supported this

Graph 5.6

Learners who do not speak English as a first language struggle to answer test and examination questions because of the lack of English language skills.



statement by saying, “Literacy is vital and [if] its concepts are not understood it [cannot] be applied.” Participant AH summarised this in saying, “Yes, most learners. . . fail ML because of lacking English. English is the key in ML.” Fourth, participant G indicated that English proficiency is essential for higher order questioning. (These opinions are widely supported by South African researchers. Spaul (2016), Reddy et al. (2016) and Robertson and Graven (2019) all indicated that language is a barrier to learning in the ML classroom.)

Table 5.3

Question: Learners who do not speak English as a first language struggle to answer test and examination questions because of the lack of English language skills.

	1	2	3	4	5
Combined	0%	18.2%	9.09%	18.2%	54.6%
Well-resourced	0%	44.5%	0%	11.1%	44.5%
SEN	0%	0%	0%	0%	100%
Under-resourced	0%	8.70%	13%	21.7%	56.5%

Participants were asked to give their views about the teacher in the classroom in this regard, does the teacher need to be very proficient in English for effective teaching of ML? 76.2% of all participants agreed or strongly agreed with this (see Table 5.4). Fifteen participants responded to the comments section of this question from which I extracted four themes. First, participant R agreed partially and indicated that as long as the teacher knows the curriculum, understands what needs to be calculated, and knows how to teach ML effectively, English proficiency is not a vital component in the ML classroom. Second, eight participants indicated that English proficiency for teachers is needed in order to give clear instructions and explain concepts correctly. Participant D said, “For the learners to understand, it must be explained properly.” Participant O further elaborated, “It is useful to be proficient in English for effective teaching and learning of ML and it is of good benefit to learners since the tests and exams comes in English.” Participant U indicated that teachers with comprehensive English proficiency will be able to offer “more [clarity], unpack topics, and be able to extract formulae using scenarios, tables and graphs.” Third, Participant I focussed on the teachers’ ability to understand the context and scenarios in ML itself before teaching it to learners: “It is important for the teachers to be able to interpret and understand content and context of scenarios.” Fourth, two participants indicated that although teachers need English proficiency to teach ML effectively in the classroom, code switching is necessary to support learners. Participant V stated, “Code switching from English to isiZulu [and] vice versa [does] have a positive impact [on] the effectiveness [of] teaching [and the] learning of learners.”

Table 5.4

Question: A teacher needs to be very proficient in English for effective teaching of ML.

	1	2	3	4	5
Combined	0%	9.38%	9.38%	56.2%	25%
Well-resourced	0%	11.1%	22.2%	33.3%	33.3%
SEN	0%	0%	0%	0%	100%
Under-resourced	0%	9.09%	4.54%	68.2%	18.2%

5.4 Teachers’ language used in the classroom

Previously participants had been questioned about the aspect of English language proficiency and how they view their and their learners’ English language proficiency in the classroom. In seeking responses to this question, I explored the factors and disadvantages inherent in not possessing

English proficiency in the classroom. The following two questions took this further by looking at the participants' use of language in the classroom and at how they feel this affects their learners.

The first of these questions posed to the participants was about which language they use when they teach their ML classes. There was a distinct pattern since 77.8% of well-resourced schools' participants conducted their lessons in English. 100% of the under-resourced schools' participants conducted their lesson in a mixture of English and isiZulu. There were no participants who conducted their lessons in isiZulu only (see Table 5.5). The follow up question was about whether participants thought learners struggle to understand them in the classroom when they use English as a medium of instruction. Combined, 63.6% of participants agreed with this and 36.4% disagreed. The noticeable difference is that only 11.1% of well-resourced schools' participants agreed and 88.9% disagreed (see Table 5.6). Since this group of participants all teach their learners in English as the medium of instruction, there is an acknowledgement that their learners, in their view, do comprehend the Language of Learning and Teaching. In contrast to this, 82.6% of under-resourced schools' participants viewed their learners as struggling to understand the language of instruction when English was used as the Language of Learning and Teaching in the classroom. The participants were given the option to comment after answering the two questions and 26 did so. From the reasons given by the participants who answered "no" to the question, "Do you think that learners struggle to understand you in the classroom when you use English as a medium of instruction?" two themes emerged. First, Participant C indicated that she moved on in the curriculum only when learners had understood the concept and second, participant D had not come across a learner who struggled with language since the main language of the school where she teaches is English.

From the replies of the participants who answered "yes" to the question, five themes emerged. First, participant AB suggested using more examples on a specific topic in saying, "[I] use more example as much as I can to make them understand." Second, Participant V made learners underline key words and made the learners learn them, thus "unpacking the problems within the scenario." Third, Participant K suggested using peer on peer explanation to "[r]e-teach/explain topics, group learners with peers [who] were able to explain what was taught in their own home language, provide notes, and have class discussion tests on terminology, [and] assert the level of understanding with learners." Fourth, four participants altered the wording in the lesson to suit the learners' academic and literacy needs. Fifth, Participant AC used simple English, participant E tried using different words, and participant AD used a level of English that was best suited to learners' level of understanding. (The literature supports these participants' approaches in the classroom. As Planas et al. (2018) have indicated, a diversity of population leads to many discourses in a classroom all of

which create opportunities for interpretation and for the negotiation of meaning in the mathematics classroom. Further to this, the challenge participants face, as Wachira et al. (2013) have noted, is that a key element and challenge related to discourse in the ML classroom will be the need to use mathematics language and articulate mathematics concepts for learners to learn both the language of mathematics and the mathematical concepts.)

A prominent theme that emerged from the “yes and no” responses was the use of code switching in the classroom. Eighteen participants indicated that they use code switching to promote learning. Participant N stated, “. . . by code switching and explaining unfamiliar context using context that is more familiar to learners as introduction.” Participant L agreed and said, “First I try to use English when I am asking the question or explaining, then [I] use isiZulu to elaborate more.” Participant R furthered this explanation by suggesting mixing both English and isiZulu for further explanation. (The literature supports this given that Moschkovich (2002) stated that learners may use code switching for various reasons including seeking clarification and communicating an explanation to teachers. Hussein et al. (2020) also stated that code switching can promote learner-to-learner and learner-to- teacher interactions in the classroom, especially for English second language learners.)

In opposition to this, Participant AG felt that if a mixture of isiZulu and English is used in the classroom, it can backfire because in a test the teacher cannot translate questions for learners. (This is supported by Lee (2010) who cautioned that too much use of code switching can have negative effects in the classroom.)

Table 5.5

Question: Which language do you use when you teach your Mathematical Literacy classes?

	English only	isiZulu only	A mixture of English and isiZulu
Combined	27.3%	0%	72.7%
Well-resourced	77.8%	0%	22.2%
SEN	100%	0%	0%
Under-resourced	0%	0%	100%

Table 5.6

Question: Do you think that learners struggle to understand you in the classroom when you use English as a medium of instruction?

	Yes	No
Combined	63.6%	36.4%
Well-resourced	11.1%	88.9%
SEN	100%	0%
Under-resourced	82.6%	17.4%

5.5 Conclusion

In this chapter I presented the outcomes of the questionnaire that was administered to the participants of this research study. The questionnaire contained several questions that required Likert scale responses and I displayed these in tables. I relied on the comments given by participants to further substantiate the outcomes derived from the responses to the questionnaire.

Chapter 6: The Mentor

6.1 Introduction

In this chapter I present my findings in relation to the teacher I have chosen to call Jan the mentor. I discuss Jan's responses to the questionnaire, my observation of his teaching, and my interview with him. I present his views on ML and how he deals with the challenges of teaching this subject. I conclude with how he feels about English and its relationship to ML in terms of the relationship between learners' English proficiency and their ML performance.

6.2 Background of the participant and his teaching environment

Jan is a teacher in his mid-thirties who teaches mathematics and ML in a prominent, very well-resourced boys' school⁴ that devotes large financial resources to developing sport. He has a bachelor's degree in education, with Primary Education as its focus, has 12 years' teaching experience, and four years' experience of teaching ML. He attended an Afrikaans school and, although Afrikaans is his home language, he feels that his proficiency in English is outstanding. Jan is a ML teacher at the school where he teaches and is also the Grade 8 lead in mathematics. This position entails the management and pacing of the curriculum throughout the academic year, and the setting up, management, and moderation of tests and assessments. He liaises with all the teachers of Grade 8 to ensure that all is on track to complete the curriculum. The Grade 8 mathematics teachers work closely together to ensure the relevance of all assessments.

For Jan, as he explained in the interview, the personal challenge for him, in joining the staff of this school had to do with the culture shock. He attended a school and then taught in one in which most of the learners were Afrikaans speaking, so taking up a position in a multi-racial, multi-cultural school, was challenging. Many of the learners at this school had won scholarships to attend the school based on their sporting abilities and talents and this meant that his classroom represented a South African demographically balanced environment. Jan found the learners' responses to and interactions with him different from what he had been accustomed to in his previous school. He viewed learners in his previous school as respectful and the learners regarded the teacher as the main authority, so they would stand up when a teacher entered the classroom and greet her or him. There was silence when the teacher spoke. All these norms relating to such standards of obedience

⁴ In the interests of preserving his anonymity I will not locate the school more precisely.

and discipline did not operate in his current school, so he had to learn to adjust to this new environment.

Jan said that his biggest challenge in working at this school is one related to communication in that not everyone can understand English. In most of his classes there are several languages spoken by the learners. In the lesson I observed, these languages were English, isiZulu, isiXhosa, and Sotho. Jan finds that learners who are second language English speakers struggle in the classroom, and this presents a barrier to learning.

He sees himself as a mentor in the classroom, on the sports field, and in the learners' home life, too, at the boarding establishment. Since there are diverse cultures, languages, and races in this school Jan always proposes that the Afrikaans speaking learners who join it are placed in his Grade 8 mathematics class so that he can be a positive influence and become a familiar figure to them since he understands the complexities of joining such a mixed learning environment. Jan refers to the fact that as an Afrikaner who moved to what can be described as an English- speaking city, he can support the Afrikaans learners in their new environment.

In a further elaboration on the teaching environment, Jan said that in the first few games of rugby at which he was present the team was struggling to play well together; there was, he said, "Something missing in the team." The school's first team rugby coach contacted a Natal Sharks Rugby coaching specialist, who is also a second language English speaker, about this. He concluded that the team did not understand the vision of the school's first team rugby coach and could not follow his instructions. The coach took time to learn the basic terms and phrases in the language of the players to gain their respect and to improve communication in the team. This strategy proved to be very successful. The team ended the season as one of the best school rugby teams. Jan indicated that this was evidence to him of how important communication is. In communicating, the team acted as a community of players who supported each other. Jan understood that constructive communication can have a positive influence in the ML classroom too.

6.3 The lesson transcript

Jan's lesson that I observed was a Grade 12 ML class. There were 17 learners of whom several had been awarded scholarships for their sporting abilities. The languages spoken in the class by the learners were English, isiXhosa, and isiZulu. Jan addressed the complexities of teaching a multi-language class by walking in between the learners as he read the questions out loud and when he

was elaborating on them. He did this to gauge their understanding and to support individual learners he believed to be struggling with comprehension.

Jan was observed using the ML National Senior Certificate (NSC) Grade 12 June 2022 Examination paper as part of his revision material for the lesson. He used the memorandum to speed up marking in the lesson instead of using time to complete the calculations. The lesson consisted of marking the work that had been set for homework. While learners were completing corrections during the lesson, Jan stood by the board and learners walked up to him and he supported them by completing the calculations (especially Q. 3.1.3, see Figure 6.4) on the board with them. Jan was a very effective teacher in his vigilance shown to learners who were struggling with the work set and with the class in general. The learners I observed were well behaved and displayed a sense of humour that Jan used to his advantage to motivate them to complete the revision work set during this lesson.

6.3.1 Lesson observation

Jan:⁵ Alright gents, let's get cracking here please. Right, question three please. The first question is asking us to look at the provincial estimated half-yearly livestock numbers in thousands of the nine provinces of South Africa from August 2020 to February 2021. Question three, OK (see Figure 6.1). Please take note of the words 'in thousands' next to [the] livestock numbers, so when you have a look at your values you have to remember that it will be in thousands. When you get your final answer, you multiply that answer by a thousand, or you just write the word 'thousand' next to it.

I noted that Jan placed emphasis on the contextual information that is crucial to the successful completion of the question. This can easily be overlooked by learners since it is information that is supplied at the beginning of the question. Jan emphasised that rather than reading the number as an actual number, it is a contextual signifier that gives the number in thousands of livestock. Hence the number must be multiplied by a thousand for it to be the correct number of livestock.

The lesson continued.

Jan: Ok, 3.1.1. The first question says, 'Write down the province with the second highest number of sheep for February 2021.' (see Figure 6.2) So, we are going to look at the table. Which one will have the second highest?

⁵ These transcripts have been lightly edited in the interests of economy and coherence.

Some of the learners in the class said, “Northern Cape” and some said, “Free State.” The learners struggled to identify the second highest number of sheep in a province in South Africa for 2021. Jan gave the class a limited amount of time to analyse the figures to identify the correct province.

A learner [speaks out and asks Jan directly]: Second highest?

Jan: Yes.

The class again takes time to evaluate the question.

A learner [confidently but quietly]: Northern Cape.

Figure 6.1

Below is an extract from the NSC Grade 12 June 2022 Examination paper 1, Question 3.

QUESTION 3

3.1

TABLE 2 below shows the estimated provincial half-yearly livestock numbers (in thousands) for the nine provinces in South Africa for August 2020 and February 2021.

**TABLE 2: ESTIMATED PROVINCIAL LIVESTOCK NUMBERS
(IN THOUSANDS) IN SOUTH AFRICA (AUG. 2020 AND FEB. 2021)**

PROVINCE	ESTIMATED LIVESTOCK NUMBERS (IN THOUSANDS)					
	Cattle		Sheep		Goats	
	Aug. '20	Feb. '21	Aug. '20	Feb. '21	Aug. '20	Feb. '21
Western Cape	466	466	2 545	2 497	202	199
Northern Cape	419	418	5 182	5 079	448	446
Free State	2 054	2 023	4 330	4 362	215	211
Eastern Cape	3 050	3 059	6 513	6 394	1 991	1 968
KwaZulu-Natal	2 380	2 320	628	610	662	651
Mpumalanga	1 248	1 243	1 527	1 508	78	76
Limpopo	860	850	A	192	902	909
Gauteng	246	246	84	83	21	20
North West	1 576	1 545	596	585	651	641
Total	12 299	12 170	...	21 310	5 170	5 121

[Adapted from www.dalrrd.gov.za]

Jan acknowledges with a nod to the learner that he is correct. He says, “When I write down Northern Cape, [I could] abbreviate it to NC, but I would advise you against it as not everyone knows what NC means.”

Figure 6.2

Below is an extract of the NSC Grade 12 June 2022 Examination paper one Question 3.1.1.

3.1.1 Write down the province with the second highest number of sheep for February 2021. (2)

A learner [raises his hand to ask a question]: Sorry, Sir?

Jan: Yes, Zwini.

Learner: If you only wrote NC would you lose a mark?

Jan: If I mark it, you would not lose a mark, but if you get marked in your final paper something else might happen. OK?

Jan emphasised to the learner that during the marking process of the final examination the markers will be stricter in marking. He indicated that the learners need to be more vigilant in how they display their answers in the examinations.

Jan: [Indicates to the learners that they are moving to the next question. 3.1.2] Calculate Eastern Cape's estimated total number of livestock for August 2020 (see Figure 6.3). OK. So now we are looking at 2020 and we are looking at the total number of total livestock. OK, what do we now have to do?

He provokes a discussion with the learners.

Figure 6.3

Below is an extract from the NSC Grade 12 June 2022 Examination paper 1, Question 3.1.2.

3.1.2 Calculate Eastern Cape's estimated total number of livestock for August 2020. (3)

The learners [responding to Jan in unison]: Add all of them together.

A learner tells Jan how he would answer the question, and, in this process, Jan guides the learner by saying how he would approach the question.

Jan: Add all of them, do you agree, and just for the Eastern Cape? Do you agree? So what do I have to show? I have to show the calculation, all the August values.

Learner: Yes.

Jan [looks at the entire class and asks them a question]: Do you agree?

Learners: Yes.

Learner: Divided by three.

Jan: Why do you want to divide it by three?

Learner: I'm just asking for the average.

Jan: Shezi what do you say? Look at your table. I need cattle, sheep, and goats. There is a column that goes down and says August 2020 and has all three of them.

Jan gives the learners adequate time to find the column that is relevant to this question. He also helps some of the learners to locate the information in the table.

Jan: OK, so when I'm looking at Eastern Cape, I only need to add the 2020 values for the Eastern Cape together and I show it by writing down the calculation or values.

Learners read the values off the table and individually three learners give the answer to Jan. He writes the values on the board as the learners say them out loud.

Jan: Ok and that will give us 11 554. Are we all happy with that, now?

Jan emphasised to the learners that the information related to the contextual signifier appears in the table. The contextual signifier is the number in thousands of livestock; the value 248 represents 248 000 livestock.

Learner [reminding them of this fact]: Don't forget the thousand, Sir.

Jan: That is where the next question comes in. Do I write down thousands here in the context of the question?

Learner: Yes.

Jan: Why?

In the above extract Jan can be seen to engage continually with the learners as they work with the contextual signifiers and the exact values these represent. The learners discuss with Jan the steps they need to take to attempt a question successfully. Jan again takes the opportunity to prepare the

learners for the examination by guiding them as to how to do the calculations and display the answers for the examiners.

Learner: Because it says at the top all the livestock.

Jan: [He gives the learners time to read the question again and debate if this learner is correct or not]
Read the question, the total number. OK so do I then assume we leave it as is or do I add in the thousands?

Learner: Add the thousands.

Jan: Make sure you read the question.

Jan writes on the board and shows the learners how to display the answer. He places emphasis on the reading necessary to grasp the contextual demands of the question that requires them to use the exact number of livestock while trying to find the missing signifier (A) from the table. He does so since the contextual information regarding the need to add the “thousand” into the answer is, as I have already pointed out, at the beginning of the question. Jan indicated that they should go back and read the question to grasp its requirement.

Jan: 3.1.3. is a little bit of a challenging question. The provincial mean number of sheep is 2 400 444. A farmer in Limpopo stated that the missing value A in the table is less than 200. Verify, showing ALL calculations, whether his statement is valid or not. OK. Now I want to take your attention to the 200. Do they refer to the 200 on its own or do you think they refer to 200 000? (see Figure 6.4).

Jan again refers back to the contextual setting of the question reminding the learners that the information they require is at the beginning of the question. He refers to the signifier 200 together with the full value of 200 000 that it represents, forcing them to see that they were looking at the same information represented differently. Jan wants to avoid having the learners forget about this crucial contextual information as they move further into Question 3.

Learners: 200 000

Jan: Do you agree?

Learners: Yes.

Jan: Why? Why do they give it to you like that?

Learner: Because it is in the table.

Figure 6.4

Below is an extract of the NSC Grade 12 June 2022 Examination paper 1, Question 3.1.3.

- 3.1.3 The provincial mean number of sheep is 2 400 444.
- A farmer in Limpopo stated that the missing value A in the table is less than 200.
- Verify, showing ALL calculations, whether the farmer's statement is valid. (7)

Jan: So how am I going to work my way around this? What are we working with? We are working with the mean number. I already [told] you what the mean is. But when I have a look at the sheep and it is for 2020, that's what we are going to be working with here. There is a missing value of A, so somewhere in my addition, to then divide to get to my mean there is a value that is missing; that value I need to find. So, I need to work backwards to get to that point. How am I going to do that?

The learners debate with each other and some learners discuss the matter with Jan. Jan gives them some time to deliberate on this matter.

Jan: Look at the mark allocation as well. It is seven marks.

Jan indicates that if the question is worth seven marks, there are several steps that will have to be taken to conclude this question successfully. He again leaves the learners to debate the matter and he again discusses it further with some learners.

Jan: Mean is the average, yes. Now how do I calculate the average? [Some learners speak out and say that you add all the values together and divide it by the number of provinces]. So looking at the values given to us, let's go put them in order, from lowest to highest. Why do I do that? Is it necessary to do it?

The learners debate this point with each other and with Jan. Most of the learners respond in the negative.

Jan: Now when is it necessary for me to put them in order?

Learners: Median and range.

Jan uses this opportunity to engage with the class and to determine if the learners can distinguish between mean, median, and mode. Provocatively, he suggests that he needs to place the numbers in order before he can find the mean and asks them why that is needed. This approach is aimed at

helping the learners to question for themselves what the procedure is to determine the mean, median, and mode for a set of data.

Jan: Median and range, do you agree? So let's go and add them all. I will say, my mean is equal to the total number of sheep. . . that is what we are looking at, divided by the total number of provinces, ok, that will determine my mean. I gave you the mean already, which is 2 400 444 and now the total number of sheep. Let us go and write them down.

Jan writes the available numbers on the board. He illustrates the method for calculating the mean by placing an A at the unknown number to be found in the question. Jan illustrated this algebraically as displayed below.

Learner: That is a lot.

Jan: It is a lot, but you have to show this, gentlemen. You have to. I know that some of you will add this up on your calculator and just write down the final answer, but you will lose a mark getting there.

Learner: What do you get if you just write down the answer, Sir?

Jan: You're going to lose a mark. [With] everything else, if you do everything else correct, you will get your marks, but you are going to lose a method mark by not showing what you are actually adding.

Jan is very explicit about this and explains several times to the learners how to write answers in the examination. He emphasises to the class the techniques that are needed to display the answers in the examination in order to obtain full marks per question.

Jan: I will show you now that I can add everything up.

Jan adds up the eight given answers and writes the answer on the board.

$$\frac{21\,405 + A}{9}$$

Jan: I don't know what the value of A is, because in essence they are asking me to find what the value of A is. So that is why I have to work it out to determine whether his statement that it is going to be less than 200 000 is correct or not. OK, so when I get that, how do I get rid of this 9?

Jan continues the calculation by showing the learners how they will solve the equation and writes the following steps on the board.

$$\frac{21\,405\,000 + A}{9} = 2\,404\,444$$

$$21\,405\,000 + A = 2\,404\,444 \times 9$$

Jan: Take it [referring to the number 9] across the equal sign. Do you agree? So, then it is going to be multiplied and I multiplied it out and it is going to give me an answer of 2 160 3996. I'm going to be left with 21 405 plus A on that side.

$$21\,405\,000 + A = 2\,404\,444 \times 9$$

$$21\,405\,000 + A = 21\,603\,996$$

Jan: Then A will be equal to this amount [pointing to 21 603 996] minus the amount [pointing to 21 405 000] because there is a plus sign in front of that value; it is a positive value take it across it becomes negative, so the answer that I will get is 198 996.

$$A = 21\,603\,996 - 21\,405\,000$$

$$A = 198\,996$$

Jan: Is that less than 200 000?

Learners: Yes

Jan: You sure, you want to . . . check there? OK, so am I done?

Learners: Yes

Learner: You have to say this statement is true or false.

Jan: Is the statement valid, yes?

Jan again reiterates to the learners that they must make sure that they comply fully with the demands of the question given. Jan reminds the learners to look at the question again to see if the question was answered fully. He guides the learners to state whether the statement was true or false.

Jan: Do you want me to show you another example?

The learners discuss among themselves if they want to be shown another example.

While Jan was giving the class the opportunity to write down the solutions to Question 3.1.3 from the board, he was illustrating to three learners sitting at the front of the class with a simpler example of smaller numbers how to find the missing number A in a question comparable to Question 3.1.3. Jan used small numbers to solve the question without using a calculator. He used this opportunity to

consolidate the learning by using a simplified calculation to solve the value for A for these three learners.

Jan: Right, next Question, 3.2. South Africa's agriculture sector sales in 2019 amounted to R317, 6 billion. Annexure B shows the distribution of these sales, as well as the further distribution of livestock sales into animals and produce. OK (see Figure 6.5).

Figure 6.4

Below is an extract of the NSC Grade 12 June 2022 Examination paper 1, Question 3.2.

3.2

South Africa's agricultural sector sales in 2019 amounted to R317,6 billion.
ANNEXURE B shows the distribution of these sales, as well as a further distribution of livestock sales into animals and produce.

Jan: 3.2.1, look at Annexure B and look at what they give us. State whether the data displayed in Annexure B is categorical or numerical data (see Figure 6.6). When I have a look at my Annexure, is the data categorical or numerical?

Figure 6.5

Below is an extract of the NSC Grade 12 June 2022 Examination paper one Question 3.2.1.

3.2.1 State whether the data displayed on ANNEXURE B is categorical or numerical data. (2)

Learner: [answers Jan confidently] Categorical.

Jan: Why is it categorical?

Learner: Because of the pie chart.

Figure 6.6

Below is an extract of the NSC Grade 12 June 2022 Examination paper one Question 3.2.2.

3.2.2 Determine missing value A. (2)

Jan: Because of the pie chart. Because the data has been given to me illustrated by means of graphs, tables, or whatever the case may be.

Jan supports the learner's understanding of the question by expanding his answer to indicate how to achieve full marks for the question. He agrees that the data can be categorised into groups that can also be illustrated through a graph or pie chart.

Jan: So that is 3.2.2. Determine the missing value of A (see Figure 6.7).

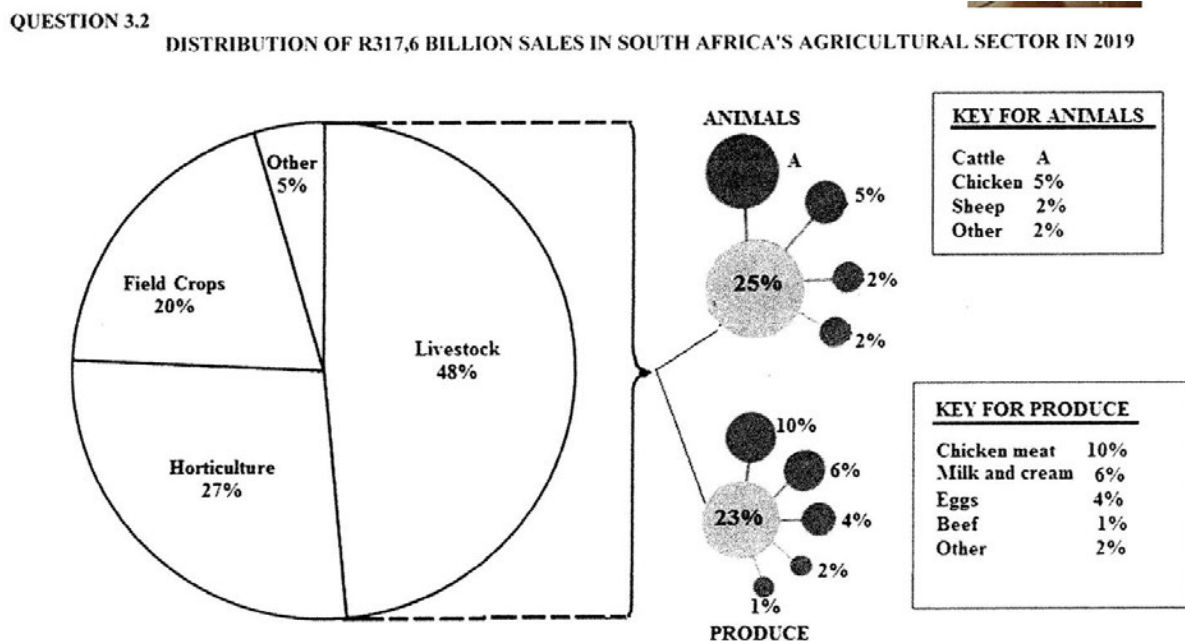
Now where do we find A? Look at the Annexure now. What do you think we need to do to find the missing value of A? Look at how they give it to us. Look at what's next to it on the left-hand side. What do you see on the Annexure? (see Figure 6.8.)

Jan gives the learners time to discuss this matter with him. He uses this opportunity to discuss with the learners how to determine where to find the missing information in a contextual setting.

Jan: How do we look at A? Do we look at A and do we find A?

Figure 6.7

Below is an extract of the NSC Grade 12 June 2022 Examination paper 1, Question 3.2. Annexure B.



Learners speak out to indicate to Jan where to find A and how they think they need to interpret the data. Learners indicate that you need to deduct the other animals' percentages from the total of 25% to find the missing value A (cattle).

Jan: Are you 100% sure?

Again, Jan uses the opportunity for the learners to interact with him in finding the correct data in the contextual setting and to discuss with him what to do with it. Jan then guides the learners in the correct direction through debate and discussion.

Jan: OK, so when you have a look where A is, there are little lines that go back to a big circle that says 25%, so A falls under the category that counts for 25%, OK? So, we need to determine the value of A. We say $25 - 5 - 2 - 2$ etc and this gives the answer of 16%.

Learners: I did it this way; could you just say 25 minus 9.

Jan: You could give it as well, so ok, if you want to say that then as a side note show that the calculation gives us 9. Go and do this. Then I (or the examiner) can give you the mark.

Again, Jan guides the learners as to how to answer a question in the examination successfully by indicating to a learner how to display the answer. The learner displayed the knowledge and skills necessary to answer the question, so Jan directs him as to how to display the answer correctly to the examiners to achieve full marks.

Jan: Q.3.2.3. Calculate in millions the actual rand value of horticulture sales. Now have a look at your Annexure and have a look at your graph. OK horticulture is how much of the total sale? 27%, do you agree?

Learners: Yes.

Jan: Of how much? 317.6 billion? (see Figure 6.9.)

Figure 6.8

Below is an extract from the NSC Grade 12 June 2022 Examination paper 1, Question 3.2.3.

3.2.3 Calculate, in millions, the actual rand value of horticulture sales. (3)

Learner: How many zeroes are there in a billion?

Jan: Nine zeros.

Jan: Write the number out and convert it to million from billion. Do this by moving the comma.

Jan: It will be 3 176 million.

Learner: No.

Jan knowingly or mistakenly gave the learners the incorrect answer. This was an opportunity for the learners to display their understanding of how to display a number in millions rather than in billions and to show Jan that they understood the contextual setting of the question.

Jan: 371 600 million.

Jan: Now I need to ask you something. Would it be easier to calculate the sum first then convert or convert first and then calculate the sum?

The learners discuss this.

Jan attempts to illustrate with a real life example that it is easier to convert the number from billion to millions after the calculation. He attempted to indicate that it is easier to calculate the sum this way.

Jan: So, 27% of 317.6 . . . what will give us? 85.75 billion. Now let's get that to million. Now how many million are there in billion, 100 or 1000?

Answers are mixed between 100 and 1000.

Jan: 1000, OK. So how do I convert that? Going from a big unit to a small unit, do I multiply or divide? Multiply?

Jan: Right. So, then this amount is multiplied.

Learner: By nine? (The learner is confused with previous question 3.1.3. He is unsure as to how to convert from billions to millions and links the previous time he heard division in the lesson with the number 9 that was used in question 3.1.3.)

Jan explains in a quieter tone to the learner that he has become confused with a previous question (3.1.3). Jan showed him on the board what was done in Question 3.1.3 in order to obtain the correct answer. Jan then came back to the current question and illustrated on the board how the answer is multiplied by 1000 to convert from billions to millions.

Jan: 85 700.

Jan: Give a valid reason why there is a category for other livestock under animals (see Figure 6.10.)
Look at your Annexure at the terms of the agriculture sector.

Figure 6.9

Below is an extract of the NSC Grade 12 June 2022 Examination paper 1, Question 3.2.4.

3.2.4 Give a valid reason why there is a category for other livestock under animals. (2)

Jan: Why is there “other” in the level 4 question? Look at the context.

Jan refers to answering the question by asking them to look at the phrase “other livestock” in terms of the context.

Learners debate among themselves about why there is a category for other livestock under animals.

Jan: Please continue now with question four on your own.

Jan concludes the lesson by giving the learners fifteen minutes to complete this new work. The class has been set Question 4 in the ML NSC Grade 12 June 2022 Examination paper 1 to complete during the lesson. During this time Jan walks in between the learners to support them in completing the question set. Again, he guides the learners and supports them when they need it. The bell goes and the class is dismissed.

6.4 Views of Mathematical Literacy and the curriculum

In comparing ML to Core Mathematics as a subject, Jan felt that ML gives an understanding of life’s applicable calculations, whereas mathematics provides an understanding of problem solving. He supported his understanding of ML further by stating, “The purpose of ML is to create a literate understanding of financial concepts as [opposed] to mathematics which is more [about] complex driven solutions.” There were three points that arose from Jan’s views of ML and the curriculum according to his Likert scale responses in the Questionnaire (see Figure 6.11). The first was Jan’s agreement with the pace of the curriculum (another 14 of the 32 respondents agreed with him) and strongly agreed that the ML curriculum can be completed in an academic year (another 11 of the 33 respondents strongly agreed with Jan). Jan agreed that learners should be taught the mathematical

content before the real-life context is introduced (and another 12 of the 33 respondents agreed with him).

The second point concerns Jan's negative views of the curriculum content itself. Jan is not content with the current topics in ML. He was neutral regarding the necessity of the topics in ML (along with only another four of the 31 respondents), the statement that the curriculum is well suited to achieve the purpose of ML (another seven of the 33 agreed), and that the sequencing of the ML topics according to CAPS makes sense (another seven of the 33 were neutral on the matter). Jan strongly disagreed that ML needs more topics such as algebra and geometry (another 14 of the 33 strongly disagreed with him).

The third point was Jan's acknowledgment of the importance of real life demands and expectations in ML. He agreed that ML learning supports learners dealing with real life problems (another 11 of the 33 agreed with him) and that ML supports learners in solving real life problems (another 18 of the 33 strongly agreed with him). (See Figure 6.11)

Jan feels that the ML curriculum has challenges that are linked to communication. He feels that the contextual challenges that ML presents in questioning makes ML a subject in which you teach more than just mathematics. As he stated, "Because its life." Jan further supported this by indicating that during his observed lesson he gave another example in a simpler manner to help a learner. I asked him if he felt that by giving the learner another example for Q3.1.3's final steps of calculation, he was addressing the learners' calculation skills or contextual skills? To which Jan confidently answered, "Contextual, yes." This was also evident in Jan's lesson that I observed since the main theme that I detected was the emphasis placed on deciphering the contextual demands in each question that was presented to the learners. Thus, he linked the contextual demands to the logical reasoning required for the question at hand.

Jan also indicated that there is a general struggle with the methodology in ML since, for example, a learner struggled with the concept *mean* and how to calculate the mean in Question 3.1.3. (See Figure 6.4). Jan was asked his opinion regarding this scenario and if this was because of a lack of preparation on the part of the learner, or if it was a function of not understanding the term *mean*, or not understanding the mathematical methodology. Jan confidently answered, "Methodology." He supported this by stating, "So that's plain methodology because that is work that has been there since Grade 8. It is something that he should know." Another struggle for Jan was the learners' use of logical reasoning in the context of the questions. For him, even when learners struggle to identify the contextual demands of each question, they also struggle to use logical reasoning in deciphering the information and in delivering the correct answer to a question. Jan explored the learners'

understanding of methodology by questioning them in the lesson and in generating a debate between the learners and himself. I asked Jan if he questioned the class by asking, “Are you 100% sure” to determine if the learners were confident in knowing the calculation method of the question, to determine if they knew where to find the correct information for the question, or to determine the learners’ process of thinking. Jan said that questioning learners in the classroom encourages them to express themselves. He added, “The methodology behind it is for me the easiest way to get there. Because I believe that I am at their level, if it makes sense for me, I believe in my mind that sometimes it should make sense for them as well.” This was evident in the conversation I observed that developed about a challenging examination question during the lesson (see Figure 6.4).

Figure 6.11

Below is an extract from the completed Questionnaire that Jan submitted.

Using the following scale of 1-5, use a number to indicate the degree to which you agree with the statements listed below, where

1	2	3	4	5
Strongly disagree	disagree	Neutral	agree	Strongly agree

2.3. I am pleased with the pace of the ML curriculum	1 2 3 4 5
2.4. I am able to complete the curriculum each year	1 2 3 4 5
2.5. All the topics in the ML curriculum is necessary	1 2 3 4 5
2.6. The ML curriculum needs to include more topics, for example algebra & geometry	1 2 3 4 5
2.7. The ML curriculum is well suited to achieve the purpose of ML	1 2 3 4 5
2.8. The sequencing of the ML topics according to CAPS makes sense	1 2 3 4 5
2.9. I believe that mathematics learning helps learners to deal with real-life problems	1 2 3 4 5
2.10. I believe that ML is necessary because it will help learners solve real life problems	1 2 3 4 5
2.11. In Mathematical Literacy, learners should first be taught mathematics content and then taught to deal with real life contexts	1 2 3 4 5
2.12. A teacher needs a strong mathematical background for effective teaching of Mathematical Literacy	1 2 3 4 5

Jan emphasised logical reasoning in saying, “So for me it is all about the identification [and] it is also about the visual aspects. You’ve got to see what the question is asking and also interpret it the correct way because when you look at the diagram in Annexure A, it was that circle, the one circle was clearly bigger than the rest of the percentages, that in itself for me gave it away.” Figure 6.8 presents the diagram to which Jan refers in the discussion that he provoked with his learners. They refer to the question in Figure 6.7 to determine the missing value of animals by calculating a missing percentage.

Besides learners reading the question and possessing the necessary English proficiency to do so effectively, Jan indicated that you need logical reasoning to interpret the question correctly from diagrams or graphs such as displayed in Figure 6.8. Jan explained that logical reasoning should prevail. In a graph in which a circle (here, labelled A) is the biggest one, it must have the biggest share of the percentage. He stated, “That in itself, for me, gave it away, but I don’t know if it has given it away to them so that is why I tried to debate it with them, so they are certain. I would sometimes go down the road of starting a question and letting them lead me from top to bottom, even if it is wrong, then getting to the bottom and [pointing out that] it is wrong and then I [would] tear it apart and we [would] go all the way back, and redo it, so they can see, ‘Ah, but this is where I made a mistake,’ and they can pick it up.”

Jan feels that the ML curriculum can be cumbersome, ineffective, and pointless. He indicated that when I asked him about question 3.2.4. (See Figure 6.10). Did he feel that this was a fair ML question? Jan stated, “That is a terrible question, I agree, 100%. I can’t believe there was a question like that ever, in a ML paper. Yes 100%. I understand the comprehension of looking at data and interpreting information in a table or in whatever, but that is the type of question that is so open ended it does not belong in a mathematical context at all.”

Jan’s discussion indicated that he is concerned about the consistency between the ML classroom and the examination paper. He stated, “The textbooks and the materials differ drastically from the exams and [this explains] my saying to the boys is that it is a lucky packet.” Jan indicated that when he and the rest of the teachers in his school in the ML department set up an examination for learners, they attempt to set up one that is guided by what learners have learnt and thus prepare them for the real examination. Jan indicated that he feels that learners are not always prepared for examinations. He said, “Last year during Covid we had to make sure the learners were prepared and knew how to prepare for the exams and what to expect. So, we made a booklet of past papers so we [could] cover the topics. Then we work[ed] on the past papers and there you pick things up and you teach on the

whim. Jan has little trust that DBE textbooks and resources are relevant and representative of the curriculum to be examined in Grade 12 ML.

Jan supports learners in preparing for examinations by placing emphasis on procedural fluency. During the lesson Jan was mentoring and guiding the learners in preparing for the examinations by placing emphasis on procedural fluency, thus preparing the learners for how to answer questions in an examination. This was accomplished by his exposing the contextual setting of such questions to the learners, showing them how to read and understand these contextual settings, and teaching them specific skills in presenting the answers in a way that the examiners expect them to be presented. Jan further supported learners by indicating that they should not write in acronyms, must use the mark allocation to identify how much demand and how many stipulations and requirements there are in a question, and must write and present answers clearly. He emphasised that learners need to display methodology in their exam, regularly referred them back to reading the question carefully and working out its contextual demands. He encouraged them to be vigilant in identifying the requirements of a question and to identify the relevant information that they require in the task information at the start of the question.

Further to this, when Jan was asked about how he felt about the language used in examinations and in the curriculum, he indicated that it is terrible and far too complex. He said, “The scary thing is [that] when they write an exam, the hands shoot up, I cannot help them and I look at the examination paper and I say [to myself], ‘Damn, I don’t even get it.’” Jan said that he needs to take the examination paper and analyse it to gain, eventually, an understanding of it himself. He noted with concern that if he struggles to analyse the examination papers and wonders how the learners get through it in three hours when they don’t understand the comprehension behind it.

6.5 English and its relationship with Mathematical Literacy

In his interview and questionnaire and during the observation, Jan explained that communication is an issue in his classroom since although the learners speak several languages, he teaches through the medium of English only. He said, “I feel that English is the language of instruction globally, so if you want to go anywhere in the world, you have to speak English.” He indicated that “the benefit of not learning in your home language is because when you go out in the real world you are going to have to re-learn what you did, [so] rather do it now in a language that is foreign to you and use it, because when you are out in the world after school it is a different story.”

Jan accommodates learners in the classroom by focusing on key words that are part of the contextual language. He explained, “Many times you get an examination that has very high functioning English [so] I will always try to explain the key words, [ask] what are we looking for, what is the question saying, [and] how can we translate it.” He further indicated in the interview that if the learners do not understand the question, he works with them to create strategies to simplify a question to identify what the question is asking of them. Jan indicated that there are three to four key words per question “that give it away.” He re-emphasised that this is his focus in the ML lesson. He is not over concerned if the learners cannot fully read the question, but they need to be able to identify the key words. Jan said, “If you can find the key word, then you can associate [it] with the work that we did in class.” He indicated that this is his main struggle in the classroom. He feels that all learners, regardless of their proficiency in English, or lack of it, struggle with language in ML. I saw this in the observed lesson when Jan asked the learners to take note of the words and of the contextual demands of the questions.

Jan said, in relation to learners’ English proficiency (or the lack of it), their use of social media and technology hinders grammatical accuracy. He said, “Look at the social dynamic, the technological age and era. Kids sit with their cell phones, they use SMS language, they try to translate it to their schoolwork, and it does not work. They do not understand because they cannot comprehend the complex words.”

Jan believes that learners who speak English as a second language battle with the complexities of ML language. He explained that in order to combat this issue, he starts the academic year with complex mathematics in the ML curriculum, and he covers topics such as finance, tariffs, and taxation, the topics with which learners struggle in ML. He said, “Absolutely, I try as much as I can when [they] stand up in class. I try [to] set [the] standard of the question paper[s, so] that they learn now, [in] term 1, massive[ly] difficult finance, and taxation and tariffs, two big topics in ML that they battle with. I always tell the boys, [that in] term 1, don’t expect good marks; it does not matter how good you are, those topics are going to throw you. It’s all about language, but when we get past those topics in term 1, then we do revision about these topics; here are your key words [and] this is what we are looking at, then they get it.” Jan indicated that learners need to explore and experience a learning curve to grasp ML concepts in context. He emphasised that there are topics in ML that are more dependent on specialist mathematical language than other topics and thus require careful consideration because of the specialist mathematical language in the learning process.

Jan further indicated that he agreed that the ML task language is too overloaded with complex language, but he feels that he does not have any way of communicating his concerns to the subject

advisors. He also indicated that he feels that if he does report this and any other concern to the subject advisors there will be no action taken regarding his concerns. Jan said, “Yes, 100%, there is not enough input from the circuit educators, we do not have enough input, and we don’t know who sets it up [and] we don’t know what influence they have in the classroom. We don’t know if they know what goes on in the classroom. The wording is just too complex for the learners.” Jan was referring to the examinations the Grade 12 learners face at the end of their academic year. This makes him and his fellow teachers question if the examiners even know what transpires in the classrooms in South Africa. Jan felt that the disparity in the views between the teachers, subject advisors, and ML subject examiners creates an environment in which the language used in the examination creates an untenable scenario for learners if they are to succeed in examinations. He said that the circuit teachers share this frustration.

Jan raised the concern that in his experience, learners grasp most ML concepts’ contextual settings but do not understand all of them. He indicated that the link between language and real life ML applications is of a contextual nature and it does make sense to learners. However, many financial documents are not seen in everyday use. He said, “I think, contextually it makes sense about what they can expect, but many of the finance documents are not something they see every day. Parents don’t show their kids finance documents; they hide them because they don’t necessarily want their kids to know what is going on. So, a lot of the actual visual things are ones the learners are not aware of [and of which they have no] word of mouth knowledge.”

Jan identified that he uses language in the classroom that promotes learners’ understanding and that improves communication with them. I asked Jan if he felt that the language he uses in the classroom influences the learning of the learners and he indicated that it does. He said, “I think it helps, I try to get to their level.” Jan achieves this by simplifying the language used in questions. Several times he gave the learners time to debate the wording of questions and the content of the questions with him and he conversed with them to support and simplify the scenario for them. “I try to make it as easy as possible,” he said. Jan achieves this by breaking down the instructions. As demonstrated above, he indicated to the learners that Question 3.1.3 was worth seven marks and, being a complex question, he broke it down into several chunks to make the calculation manageable. He explained, “I also try to use examples out of life, just to simplify [concepts].” Jan illustrated this by giving a simpler scenario and simplified calculations to the learner who needed support with Question 3.1.3 towards the end of the lesson. “I always encourage them that with level four questions they should not write down a definition. When I want a definition, [I tell them] ‘I want your own words.’” Jan encourages learners to make their own meaning of the definitions in ML. He displayed this when he asked the learners if specified data was categorical or numerical. As noted above, one learner

Figure 6.12

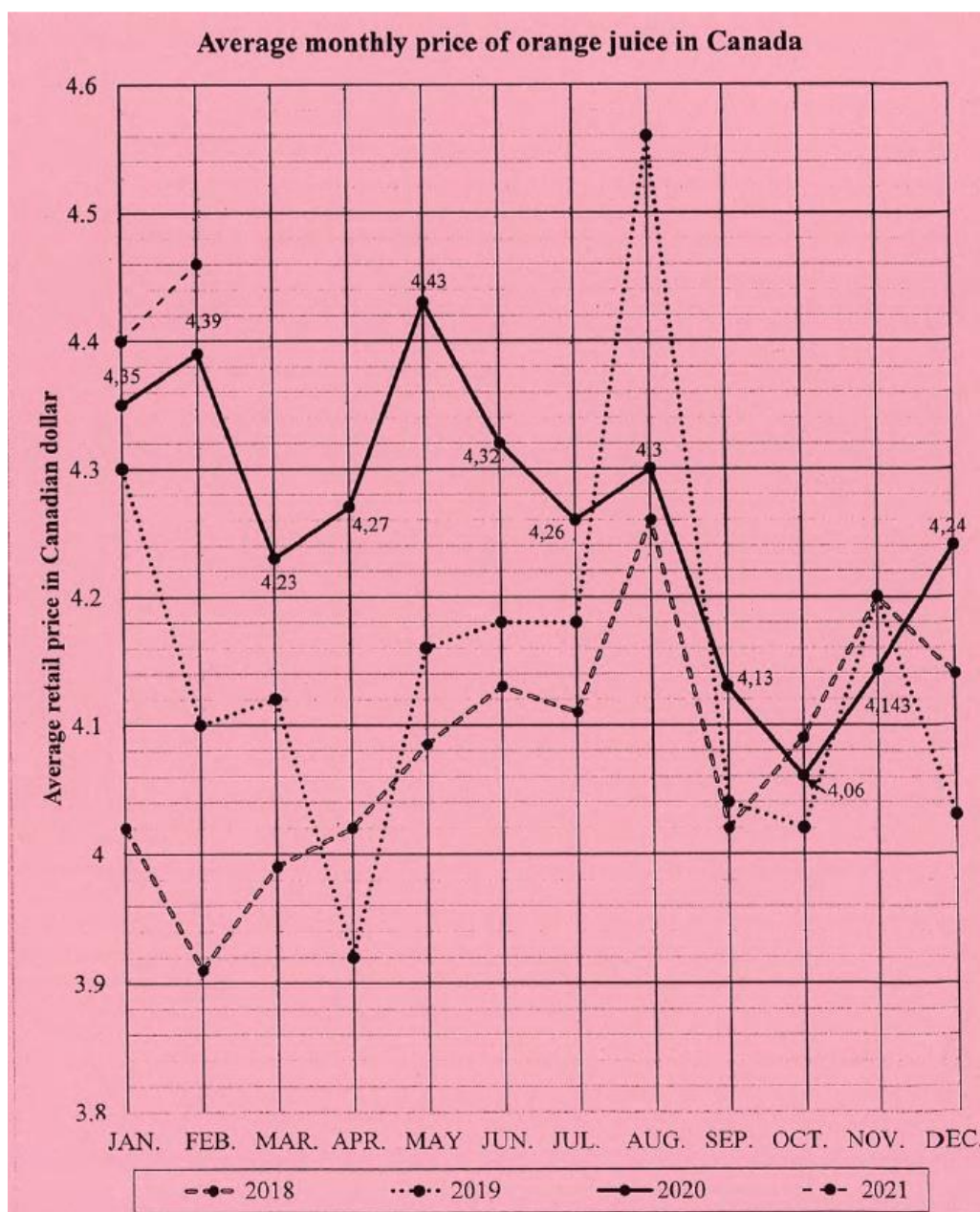
Below is an extract of the NSC Grade 12 June 2022 Examination paper 1, Question 4.1.3.

4.1.3 State the month and years in which the price of orange juice was exactly the same.

(2)

Figure 6.13

Below is an extract of the NSC Grade 12 June 2022 Examination paper 1, Question 4. Answer sheet.



responded with categorical because of the pie chart. Jan guided and supported the learner's response by indicating that the data is categorical because it can be illustrated by means of graphs, tables, or charts, thus creating the opportunity for the learner to make his own connection between the definition of categorical in data handling and interpreting it in his way to grasp the definition.

Jan identifies that learners need to read a question several times to determine what the mathematical demands are in the contextual setting. Jan indicated, "To identify the key words, for me it's all about the key words, identify the key words [and] once the key words are there then you can base your answer on that." Jan's technique was to get the learners to read the question several times to identify the key terms of the contextual language, since the context has a language of its own. Jan indicated that some learners in his classes who struggle with the English language have excelled in the examination papers "purely because they snapped the simple thing that the question asked, and it is not because they necessarily had the comprehension, but they understood what the question asked, based on the key words."

I observed during the lesson that several learners struggled with Question 4.1.3 in the NSC Grade 12 June 2022 Examination paper 1 (see Figure 6.12). Jan indicated that they were not confident in extracting information from the graph. They did not know how to use the information displayed on the horizontal or vertical axes to extrapolate accurate data. (See Figure 6.13). I asked Jan if he believed that this struggle arose from a lack of understanding of the wording of the question or a lack of mathematical skills. He indicated that it was a failure to understand the word or what he called "the English language comprehension." For him, in most instances language comprehension is a bigger contributor to the struggles of learners in ML than their mathematics knowledge. Thus, as mentioned above, Jan emphasised the need for learners to read a question several times to determine what the mathematical demands are within the contextual setting.

6.6 Jan's mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework

In this section I use the 4QCCDF as outlined in Chapter 3 to identify how Jan supports learners when they are working with ML tasks. During the lessons that were observed he used tasks taken from a previous examination paper.

The first task (Question 3.1) that was discussed, was based on the provincial half-yearly livestock numbers. In analysing the task, one can see that the contextual information contained contextual signifiers (livestock numbers expressed in thousands), (see Figure 6.1 to 6.4). The instructions are

complex in nature and contained dense contextual language (see Figure 6.1 to 6.3). Halliday (1993, p. 76) suggested that scientific [and mathematics as well as ML] texts have a very high “lexical density.” In other words, they have many lexical items (or content words) per clause. Informal spoken language has a lexical density of about two content words per clause, and written English has a lexical density of about four to six words per clause. If we analyse the instruction of Question 3.1.1 for example, we find that it has a lexical density of approximately nine content words in the sentence making up the instruction: “Write down the province with the second highest number of sheep for February 2021.” Similarly, the lexical density for Instruction 3.1.2 is nine in the short clause. Instruction 3.1.3 has three sentences; in the first one, all except three, are content words. All this implies that the text involves a high level of CALP (in its use of academic registers).

Furthermore, many of the questions are cognitively demanding in requiring multiple steps and the coordination of information. For example, Question 3.1.2 requires learners to identify the six columns giving information about the sheep, cattle, and goats, and select the relevant three columns pertaining to August 2020. They then need to identify the correct row on which to read the values from the three columns, and to add these numbers. The final step is to interpret these as signifiers representing thousands and not just the numbers given. Hence Question 3.1 can be balanced in Quadrant B as being context-embedded and cognitively demanding.

In working with Task 3.1, as seen in the lesson description, Jan continually moved from Quadrant B to Quadrant D by unpacking the dense language and extracting the relevant contextual information that the learners needed. He guided the learners to the mathematical demands in the questioning. Jan said to the class, “Look at your table. I need cattle, sheep, and goats. There is a column that goes down and says August 2020 and has all three of them.” Here Jan was helping learners to extract the information required from the question’s contextual setting and simplify it into a numerical calculation. Jan pointed out to the learners that when there are three provinces required to calculate the mean, you use the number 3. By simplifying the questions, he helped learners to identify the calculations that they needed to do, so he also moved from Quadrant B to Quadrant C when he identified the signifier of the task to the learners. Jan said, “Read the question, the total number. OK so do I then assume we leave it as is or do I add in the thousands?” Once the signifier was identified, Jan elaborated on the single mathematical computation required to present the numbers of livestock in the correct numerical order.

For Question 3.1.3 (see Figure 6.4) Jan shifted from Quadrant B, in which the question is categorised, to Quadrant D. The task is placed in a complex contextual setting and is a difficult multi-step, cognitively demanding question. Jan extracted the information from the complex

contextual setting for the learners to help them solve the question using an algebraic illustration to find the missing value A. Solving the question using algebraic illustration, Jan removed the contextual setting from the calculation and shifted from Quadrant B to Quadrant D since the question needed to be solved within the bounds of contextual rules. Later in the lesson Jan supported some learners with Question 3.1.3 (see Figure 6.4) by using another simplified numerical example to illustrate how to complete Question 3.1.3. Jan said to the learners, “Do you want me to show you another example?” Jan thus moved from a multi-step complex question placed in Quadrant B by removing the context of the question and simplifying the calculation, thus moving to a combining of elements of Quadrant D and then to Quadrant C by simplifying the calculation to consolidate the learning of mathematical skills by the learners in a simplified manner.

Jan also worked with questions that can be seen as suitable for Quadrant A (context embedded but cognitively undemanding). Question 3.2.2 (see Figure 6.7 and 6.8) is categorised as a Quadrant A question because it is placed in a contextual setting, but the mathematical demands of the question are not high. The question requires a one-step calculation. The mathematical information is easily extractable from the context of a pie chart being used to display the distribution of sales in the agriculture section of South Africa in 2019. Jan said to the learners, “OK, so when you have a look where A is, there are little lines that go back to a big circle that says 25%, so A falls under the category that counts for 25%, OK? So, we need to determine the value of A. We say 25 minus 5 minus 2 minus 2 and this gives the answer of 16%.” Jan guided the learners to extract the required information from the pie chart in order to make the one step calculation, thus moving from Quadrant A to Quadrant C to support the learners to complete the question successfully.

Question 3.2.3 (see Figure 6.8 and 6.9) can be placed in Quadrant A because it is a 2- step question placed in a contextual setting. Learners needed to calculate 27% of R317. 6 billion and to express the number as millions. The learners did not find this simple. Jan illustrated with the real-life example that it was easier to convert the number from billions to millions after the calculation. Thus, he supported the learners in this question, placed in Quadrant A, by reminding them about conversions from billions to millions and advising them to do the conversion after they completed the calculation for the question. He simplified the calculations they needed to do so he changed the demands of the task to those of Quadrant C. Jan supported three learners who came to him after he explained the question to the class. Quietly, he showed them on the board what to do, changing the contextual setting to what he conceived to be more appropriate for these learners to comprehend and enable them to compute the mathematical demand posed by the question.

6.7 Conclusion

In this chapter, I presented the findings from the data collected from Jan's questionnaire, from my observation of his lesson, and from our interview. I discussed his background and teaching environment to indicate the conditions in which he teaches. I presented the lightly edited transcript of the lesson I observed to offer insight into his teaching. Following this, I explored Jan's views on ML, on the ML curriculum, and on its relationship with English to present his perspective on, and approach towards, this study's research questions. It was noted that Jan continually supported learners by identifying the signifiers in questions, identifying the contextual rules in the contextual settings, helping them to extract the mathematical demands from the contextual settings, and breaking down multi-step questioning into single-step calculations. Thus, questions Jan gave to learners were ranged in the 4QCCDF in Quadrants A and B, but it was noted that the common path Jan used was to move to Quadrant C by supporting learners in effectively arriving at the solution of the questions presented in the classroom by removing the context and simplifying the calculations. On a rare occasion, he was observed staying in the same quadrant of the model as he simplified the calculations of the mathematical demand of Question 3.1.3 (see Figure 6.4) within a contextual setting that he considered would give learners the opportunity to grasp a clearer understanding of the mathematical demand.

Chapter 7: The Code Switcher

7.1. Introduction

In this chapter, I present the findings related to the participant I call Nothando the code switcher. This includes reference to her questionnaire, extracts from the lesson I observed, and commentary on her interview. The purpose of this chapter is to present how Nothando interprets ML and her opinion on the challenges of teaching ML. I conclude the chapter with my findings of how Nothando feels about English and its relationship with ML. The aim of this analysis is to determine whether Nothando believes that there is a relationship between learners' English proficiency and ML performance.

7.2 Background of the participant and her teaching environment

Nothando is a teacher estimated to be in her mid-thirties who is trained in mathematics. However, she indicated that she teaches ML only in an under-resourced school in a North West township of Durban. Nothando has a Diploma in Chemical Engineering and a PGCE. She indicated that to become eligible to teach ML she attended the initial workshops offered by the DBE for ML training. Nothando is an experienced teacher, having taught for 14 years with the last 12 as an ML teacher. She teaches in a severely under-resourced quintile 3 school, i.e., one with minimal resources, the least resourced school in which I observed a class for this research study. Nothando's teaching environment is very challenging; in the classrooms, there are no doors, very few windows panes still have glass in them, and there is no electricity. The walls separating the classrooms were built to the height of the ceiling board and there is no ceiling board to separate neighbouring classrooms from each other so the noise from other classes disrupts teaching and learning in the classrooms (see Figure 7.1 and 7.2). Nothando said that it had been like that for a very long time and had become the norm.

Nothando presented a professional and balanced rapport with the learners, highly proficient classroom management skills, and displayed a sense of humour in managing classroom behavior. However, she disciplined learners when it was necessary and was consistent in how she managed them. The work produced by the learners was of a high standard and they were very attentive in class. I derived Nothando's designation as code switcher because she was the observed participant who used code switching the most. In her interview she indicated that she was unwilling to give a false version or impression of how she conducts her lesson, and for that I am grateful.

Figure 7.1

Displays how the roof is constructed in a block of three classrooms and how this creates a challenging teaching and learning environment.



Figure 7.2



Figure 7.3

An extract from the completed Questionnaire Nothando submitted in relation to her view of her own English proficiency.

3.2. I am very proficient in speaking English

1 2 3 4 5

Nothando is an isiZulu home language speaker, but it was evident that she is very proficient in English as she indicated above. Her choice to use code switching was to benefit the learners rather than being a display of her lack of proficiency in speaking English. She further motivated the use of code switching in the classroom given that there were mainly isiZulu speakers along with some isiXhosa speakers.

Nothando was very observant in the classroom and highly supportive of learners who were struggling with written work in ML. When she gave them time to complete work, she would walk between the learners looking for those who needed help. She said, “I’m trying to fit in individual attention where I can because after some time you know which learners have which challenges, so I just concentrate on [them].” Her challenge in teaching in her school is the language barrier. She explained, “Because English is not our mother tongue, it’s not our first language [and] it’s not even necessarily our official language of learning and teaching. We have to code switch because [our learners] are really not used to the language. The language is a challenge.”

7.3 The lesson transcript

I observed Nothando for two Grade 10 ML lessons. The class consisted of more than 50 learners in each of the two lessons. She told me that all her learners are from the local area and that all of them come from poor households. The observed learners were mostly isiZulu speakers, and the remainder spoke isiXhosa. Nothando addressed the complexities of teaching learners who do not speak English as a first language by using code switching to support them in understanding the challenges presented in ML.

I observed a certain distinct use of language in Nothando’s lessons. She explained the definitions of key words in English but when explaining methodology, she spoke in isiZulu at the level of the learners to support them in understanding the methodological requirements in each question. She read the questions aloud in English and directly after reading the questions out in English she translated them into isiZulu and phrased them in a way that she felt would be more meaningful to her learners. She simplified the wording of the questions to make the contextual setting more distinguishable and intelligible for the learners. She wrote only in English on the board even when she explained to the learners in isiZulu.

Nothando printed out past examination paper questions and she handed them out to the learners. These questions were completed in the lessons I observed. Nothando was very efficient in explaining the topics of the lessons and having the learners engage with the work. For long periods of time, I observed her supporting her learners as they were completing the tasks, rather than giving whole class instruction. Following are extracts taken from the two lessons observed.

7.3.1 Lesson observation

Nothando⁶: *Take out your books out and write the date and the key words.*⁷ (see Figure 7.4 and 7.5).

So now, when you represent, you are representing data. We are now looking at graphs, graphs of data handling. So, there are different types of graphs that we use in data handling. Today we are doing a bar graph. *Bar graph is [used] to compare, it means if the bar is tall there is more of something and if it is short there is less of something.*

Nothando illustrates here that she speaks English to explain key words in the observed lessons. She supplements her English description of the key words “bar graph” by using isiZulu to further simplify the definition. She uses language to which the learners can relate.

Nothando: *In the vertical axis and the height of the bars, the bars must be spaced evenly.* Let us give an example. [Nothando writes pass percentages of Grades 8–12 on the board]. The main objective is to compare. A bar graph is there to compare. *A bar graph is there to compare.* There will be a bar in the graph for each grade.

Learner: Is this data handling?

Nothando: Data handling is the topic. We are looking at different types [of graphs].

Nothando: *We are working with numerical data.* This is numerical data, guys. Numerical data, guys. There is numerical and . . . ?

Learner: [speaks clearly and confidently] Categorical.

Nothando: And categorical data, guys. *Angezi?*⁸

Learners: Yes.

In the above extract Nothando uses code switching to further explain and clarify terms. She refers back to the key words to direct the learner who asked if this was data handling.

Nothando: [Draws up a bar graph and labels the axis.] 0 to 100%. *We use the bar graph for past percentages for Grade 8 to Grade 12.* The bars will be labelled as grades. First one?

Learners: Eight.

⁶ This transcript has been lightly edited in the interests of economy and coherence.

⁷ Translations into English from isiZulu are in italics. This is important if we are to identify Nothando's emphases when she is code switching.

⁸ This translates to “Are you with me or are you following?” This phrase is used several times during the observed lessons.

Nothando: *We give the Grade 8s a pass mark of 45%. So that is my Grade 8 pass percentage.*

[Draws a table of the pass rates in numbers so it is visibly displayed on the board. The Bar Graph shows the pass percentages for Grades 8 to 12].

Nothando: There are types of Bar Graphs.

Learner: [speaking confidently] Single.

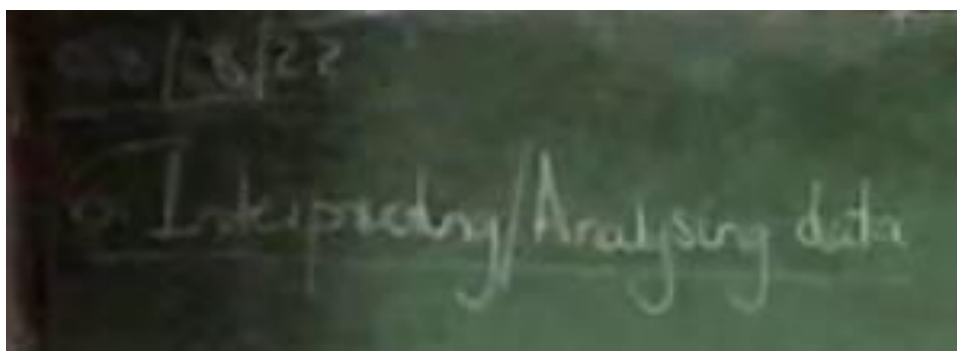
Nothando: [writes the terms multiple bar graph and stacked bar graph on the board as key words].

You get multiple bar graphs and stacked bar graphs. [In]multiple bar graphs you compare [a lot of] data together in several bars and [in] stacked bar graphs the data is [stacked]on top of other data in one bar.

Nothando went beyond the demands of the question by asking learners if they knew what multiple and stacked bar graphs are so as to gain an understanding of their knowledge of bar graphs. Again, she elaborated in isiZulu to ascertain the learners' understanding in an explanation that she believes to be more intelligible to the learners.

Figure 7.4

Displays further evidence of a key word on the board during the observed lesson.



Nothando: [moving to a different question] So, number one. We are trying to see if, without actually drawing the graph, you can understand the graph. If we can answer the questions, it means that we understand the information regarding this pie chart. OK, so now they say, 'Consider the pie chart below and answer the questions that follow: November 2012 examination results for Grade 10 ML' ... so [these are] Grade 10 ML, November 2012 examination results. They wrote the [exam] of ML [and] the data was collected. They wrote the examination and then data was collected on their results, on the marks that they got. OK, so this is what we are expected to see. . . [They put] the

achievement in order *in terms of levels of percentages* and then converted them to levels.

Percentage 0–29 is one level, level 2 is 30 – 39. You get me?

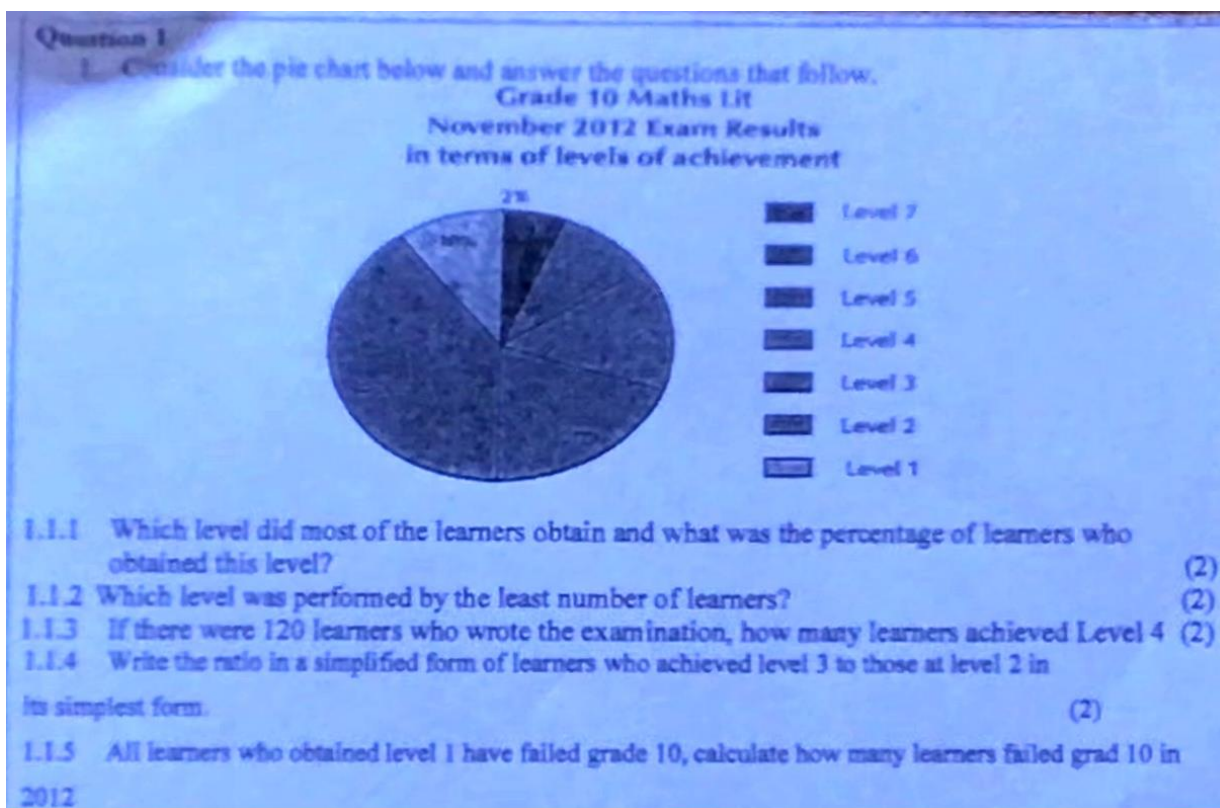
Learners: Yes.

In the above extract it is clear that Nothando committed a considerable amount of time to emphasising a crucial point to help the learners complete the question successfully. She gave the contextual setting of the question before identifying its mathematical demands. She emphasised the importance of the data collection process and how to identify the categorisation of data collected before indicating how to display the data in a pie chart. Nothando explained that levels of data are categorised, and this is a contextual signifier for the question.

Nothando: Question 1.1.3. If there were 120 learners who wrote the examination, how many learners achieved level 4?

Figure 7.5

Shows a question used during the observed lesson.



The learners discussed this.

Nothando: But they say there 120 learners *there are 120 learners*, total learners is 120. How many learners achieved level 4? Level 4 is 15%. So, a total of 120 [Writes 120 on the board as she says it out loud]. What percentage of learners got level 4? How many learners achieved level 4?

Class: 15%.

Nothando writes on the board the method of calculation $\frac{15}{100} \times 120$ So 18 learners? (See Figure 7.6.)

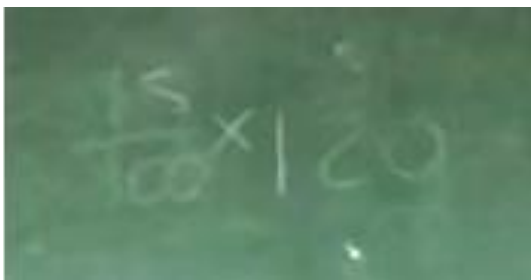
Nothando: 15% of 120. So, 18 learners?

Class: Yes.

Nothando: 18 learners, do not just write 18.

Figure 7.6

Displays evidence of the method used by Nothando to complete a percentage calculation.



Nothando is very meticulous about the methodology in Question 1.1.3 by visually showing the learners how to present the method used to obtain the correct answer (see Figure 7.6). She also explains to the learners that you cannot represent an answer without a descriptor. So, she indicates to the learners that the answer is 18 learners who obtained a level 4 for the examination, so they should not present the answer as just 18.

Nothando: Question 1.1.4. Write the ratio, in a simplified form, of learners who achieved level 3 to those at level 2, in simplest form. Write the ratio, in a simplified form, of learners who achieved level 3. Did you see level 3? 40%, so we are writing a ratio of level 3 to level 2, level 3 to level 2. Level 2 is 20%, as I was telling you. Level 2 is 20%. Copy it over. She writes on the board. (See Figure 7.7.)

Nothando: *Write in the correct order.* In the correct order, they say level 3 to those at level 2. So, they say level 3 first then level 2. It is 40 to 20. We need to simplify. Simplify on the calculator, 40 over 20. *So, what is the answer?*

Learners: Two is to one.

Nothando: [Writes two is to one on the board]. So, what is the ratio? 2 is to 1 (see Figure 7.8). Ratio doesn't have units. Don't use units. *An example is a ratio of boys to girls, ratio is written in numbers of boys to girls, and you do not write boys to girls, just the numbers.* If you can say ratio 15 boys, 17 girls, we say 15 to 17 [with] no units.

Figure 7.7

Displays evidence of the method used by Nothando to display the ratio required for Question 1.1.4.

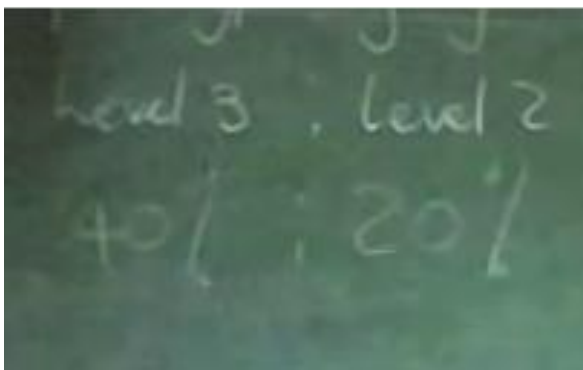
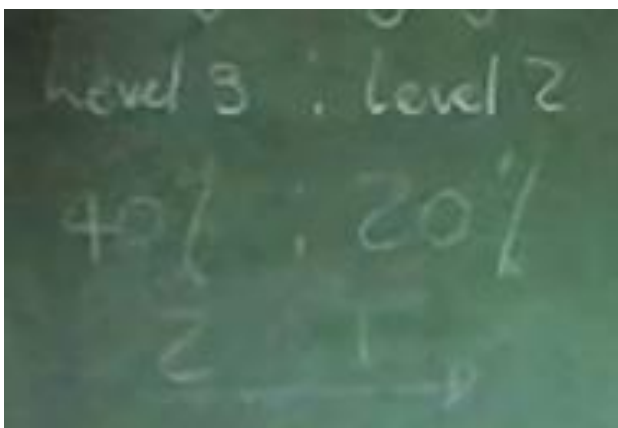


Figure 7.8

Displays evidence of the method used by Nothando to display the simplified ratio required for Question 1.1.4.



In the aforementioned extract, after reading the question to the learners in English, Nothando emphasises the mathematical demand in isiZulu so that they know right away that the ratio needs to be displayed in the order required by the examiner. She further explains in English how to simplify the ratio (see Figure 7.7) and, again using isiZulu, explains in a simplified example to the learners how a ratio is presented without units, thus placing emphasis on the presentation of the data to present the correct answer.

Nothando: Question 1.1.5. All the learners who obtained level 1 have failed Grade 10, all learners who obtained level 1 have failed Grade 10. Calculate how many learners failed Grade 10 in 2012. *Calculate how many learners failed.* All learners who obtained level 1 have failed. The question is how many learners? How do we know? We know it is 10% of learners, so what is the total number of learners? The total number of learners?

Some learners: 120.

Nothando: The total number?

Learners: 120.

Nothando: *We use this method to calculate the answer*, [referring to Question 1.1.3 that is still displayed on the board], (see Figure 7.6). The question is, how many? 10% of 120. *Look at the calculation on the board. Instead of 15% we now use 10%.* The answer is 12 learners.

In the above extract Nothando reads out the question in English meticulously in order to place emphasis on the mathematical demand and the contextual demand of the question. Nothando repeats the key concepts of the question and again indicates to the learners how to display the answer correctly for examination purposes.

Nothando: So now, question 3 contains all the steps to data handling. Nishen tested positive for Covid 19 on the 10th of August, 2021. He immediately went into isolation and followed all his doctor's instructions for a full and speedy recovery, one of which was to keep his mind occupied. He decided to keep a record of the number of new cases of deaths in his district, province, and country for each of the 14 days he had to isolate. *When you look on the television you see data and numbers and how many new cases there are. How many new cases are there?* The table below shows the data he obtained from the NICD⁹ and the KZN Department of Health Facebook pages.

⁹ National Institute For Communicable Diseases

Table 1 records new cases and the number of deaths. Table 1 records new cases and the number of deaths. These are two pieces of information, new cases and number of deaths. So, the first one is the 10th of August. On the 10th of August there are in South Africa 6590 new cases and then in South Africa there are 189 daily deaths according to the data. Now he comes to Kwazulu-Natal. Kwazulu-Natal on the 10th of August there were 1025 new cases and 3 deaths on that day. *The cases of deaths, in Ethekweni, how many cases are there? Ethekweni, the district where you stay.* In Ethekweni on the 10th of August there were 526 new cases and only one death on the 10th. *You count 1, 2, 3 ... 14. We start in the country and then go to the province, then go to the district, how many cases, and how many deaths? It is first new cases then deaths. How many new cases there are in Ethekweni. When it comes to Ethekweni we count the number of deaths.*

In the above extract it is clear that Nothando places emphasis on the introduction to the question. It is a long introduction and it has contextual information that is crucial to the question. Nothando read the introduction to Question 3 out in parts and after reading every crucial contextual cue she repeated it in isiZulu and rewords it in a manner that is more intelligible to the learners. Throughout her reading she placed emphasis on the two pieces of crucial contextual information—new cases and deaths, the pivotal components of Question 3.

Nothando: 3.1.1. Is the data on the table discrete or continuous? Yes [Pointing to a learner].

Learner: Discrete.

Nothando: Very good, but I need to know why? [Walks to the front of the classroom and repeats] But I need to know why?

Learner: Because of the number of people.

Nothando: Because of the number of people which means it is going to be whole numbers. It is data that is counted. *If it is not counted it is measured, it is exact, and if it is measured it is continuous.* They firstly ask you why, firstly, because it is the number of people. If it is the number of people, then what? This will be a whole number only. It is data that is counted. *Only when it is counted. If it is not counted, it's measured, it is no longer discrete.*

Learner: Continuous

Nothando: *So, there are decimals or no decimals? How many cases were counted on that date?*

In the above extract Nothando probes the class for more information by referring to needing to know why. She does so in order to ascertain if the learners understand the difference between discrete and continuous and, again, she introduces the key words in English and describes them in

isiZulu so the learners gain an understanding of the concepts discrete and continuous. In the explanation in isiZulu, Nothando guides the learners on how to display the answers correctly for examination purposes.

Nothando: Good. 3.1.3. On what date is there an outlier, on what date in the above? *On what date will there be an outlier, I don't know.* I will explain it when you are in Grade 12. So let us look for an outlier. On what date is there an outlier in the above data? So, we are expecting more? It can be much bigger, it can be much smaller. Does not have to be only much bigger, it can be smaller than the rest. So, you are comparing it to the rest of the data. Are you looking at cases or deaths?

Class: Deaths.

Nothando: So, you are looking at deaths. For all the other days. If you look at deaths, except for the 10 August, 3 in KZN. So what date? So, 10 August.

In the above extract Nothando uses isiZulu to make the mathematical demand known to the learners since they were not aware of what an outlier is. The question became easier for the learners; their response to the question was correct.

Nothando: 3.1.4. Calculate the mean, calculate the mean, define mean? [Nothando waits for a while for the learners to respond, the class is silent] Oooohhh.

The learners discuss this. They do not seem sure about the meaning of mean.

Nothando: *How to calculate the number of new cases, the sum of the value of the cases for the period of fourteen days.* It is the sum of the data values divided by the number of data values. So, calculate the mean number of new cases in eThekweni for the period the above data was counted. Calculate the number of new cases. Don't go to the wrong column. You want the new cases for Ethekeweni for the period above that were collected for 14 days. *For how many days?*

Learners: 14 Days.

Nothando: *The new cases for Durban for the period of fourteen days.* New cases, good, new cases in Ethekeweni. *Write down the 14 values.* [Nothando writes mean on the board]. The rest of us are writing down those values.

Nothando walks between the learners and supports them. She speaks to a learner and turns to the class.

Nothando: No, we need the sum first, we need the sum. *We need the sum.*

She walks between the learners again and supports them.

Nothando: OK so we got 18 454.

Learners: Yes.

Nothando: [Writes the sum on the board] Divided by?

Learner: 14.

Nothando uses a calculator to identify the answer.

Learner: 1324.64287 (see Figure 7.9).

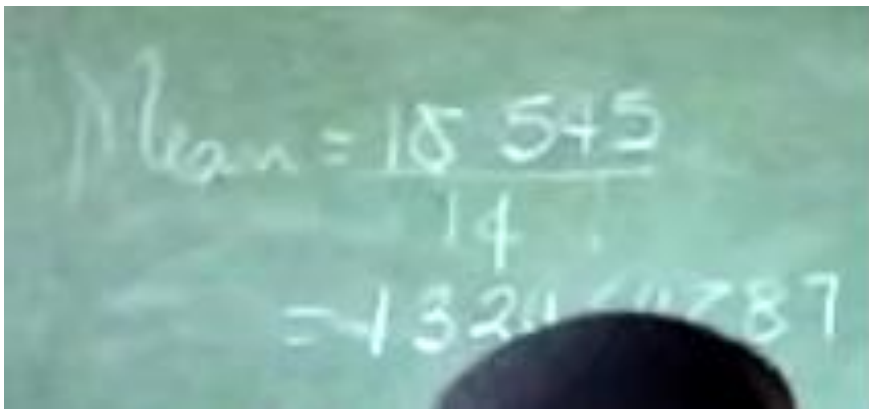
Nothando walks between the learners discussing Question 5 and its mathematical demands.

Nothando: *The answer to the calculation is 1324.64287* (see Figure 7.9).

She writes the answer on the board as she reads it out aloud. The learners discuss and debate the answer with Nothando.

Figure 7.9

Displays the evidence of how Nothando illustrated the calculation of the mean for Question 3.1.4.



A photograph of a chalkboard showing a handwritten calculation. The word 'Mean' is written on the left. To its right, the number 18 545 is written above a horizontal line. Below the line, the number 14 is written. Below 14, the result 1324.64287 is written. The handwriting is in white chalk on a green chalkboard.

$$\text{Mean} = \frac{18\ 545}{14} = 1324.64287$$

In the above extract it is clear that the learners displayed no memory of the understanding of mean. Nothando used isiZulu to introduce and revise mean to have the learners gain an understanding of how to calculate the mean of a set of numbers. Nothando again placed emphasis on the pivotal contextual cue indicating that the learners need to look at the correct column of new cases in Ethekeweni.

7.4 Views of Mathematical Literacy and the curriculum

Nothando understands ML to be the precursor that explains the role of mathematics in real-life. She said, “ML helps to understand the role that mathematics plays in the real world.” To support this statement even more, she said that mathematics is for most part theoretical and at the same time ML involves itself with real-life situations.

There were three points that arose from Nothando’s views of ML and the curriculum in the Likert scale questions obtained from the questionnaire (see Figure 7.10). The first was her agreement with the pace of the curriculum (another five of 32 respondents strongly agreed with her) and she strongly agreed that the ML curriculum can be completed in an academic year (another 11 of 33 respondents strongly agreed with her). The last factor here is that Nothando strongly believes that learners should be taught the mathematical content before the real-life context is introduced (another four of 33 respondents strongly agreed with her).

The second point relates to Nothando’s positive views of the curriculum and its content. She is very satisfied with the current topics in the ML curriculum. She agreed with the necessity of the topics of ML (along with 23 of 31 respondents), strongly agreed that the curriculum is well suited to achieve the purpose of ML (along with 23 of 31 respondents), and strongly agreed with the sequencing of the ML topics according to CAPS (along with 21 of 33 respondents). She strongly disagreed that ML needs more topics such as algebra and geometry (along with 14 of 33 participants).

The third point was Nothando’s acknowledgment of the importance of real life demands and expectations in ML. She strongly agreed that ML supports learners in solving real life problems (along with 18 of 33 participants) (see Figure 7.10).

Furthermore, in the interview, Nothando expressed concern over contextual familiarity. She indicated that this is because her learners are from poor and impoverished backgrounds. She said, “It’s just that most of the contexts are not familiar to the kids in the township. They are writing the same paper that the kids in the suburbs [are] writing [but the latter] have been exposed more than ours.” This was evident in the lesson observations since the main point I detected was her use of code switching to support learners’ understanding of mainly contextual demands and to have them familiarise themselves with the contextual setting before addressing the mathematical demands of each question.

Nothando indicated that she teaches more than just ML in the lesson because of the contextual challenges ML presents in its questions. When Nothando was asked about her thoughts on how language links to real life ML applications she indicated that there are serious gaps in her learners’

learning because of the contextual challenges. She said, “ [regarding] the electricity bill, they don’t even get the bill in their houses, we go and buy on [a bank] card and ML will have a document that is a bank statement. They know [what] a bank account [is] but they don’t know what a bank statement is because they [have] never seen [one], so we have to do more explaining and then tell them about things that are unfamiliar to them and try not to confuse them. That is the challenge.”

Figure 7.10

Below is an extract of the completed questionnaire Nothando submitted in relation to her opinions about ML.

Using the following scale of 1-5, use a number to indicate the degree to which you agree with the statements listed below, where

1	2	3	4	5
Strongly disagree	disagree	Neutral	agree	Strongly agree

- 2.3. I am pleased with the pace of the ML curriculum 1 2 3 4 (5)
- 2.4. I am able to complete the curriculum each year 1 2 3 4 (5)
- 2.5. All the topics in the ML curriculum is necessary 1 2 3 4 (5)
- 2.6. The ML curriculum needs to include more topics, for example algebra & geometry 1 2 3 (4) 5
- 2.7. The ML curriculum is well suited to achieve the purpose of ML 1 2 3 4 (5)
- 2.8. The sequencing of the ML topics according to CAPS makes sense 1 2 3 4 (5)
- 2.9. I believe that mathematics learning helps learners to deal with real-life problems 1 2 3 4 5
- 2.10. I believe that ML is necessary because it will help learners solve real life problems 1 2 3 4 (5)
- 2.11. In Mathematical Literacy, learners should first be taught mathematics content and then taught to deal with real life contexts 1 2 3 4 (5)
- 2.12. A teacher needs a strong mathematical background for effective teaching of Mathematical Literacy 1 2 3 4 (5)

When learners struggle to identify the contextual demands of each question, she reads out the vital parts of a question several times and then code switches to place emphasis on the contextual demands of the question.

Nothando does note that there is a distinct difference between ML and mathematics. She said, “Our learners switch[ed] from pure mathematics and came to ML [because] they found pure mathematics difficult and thought they will do better in ML, and then you find they do not do well in ML because the subject is so different.”

7.5 English and its relationship with Mathematical Literacy

Nothando was very meticulous in how she taught her learners. She considers their level of English comprehension and accommodates the learners accordingly by using code switching to further their understanding in the classroom. She teaches her classes with a mix of isiZulu and English and she used the most isiZulu in her code switching of all the participants I observed. Nothando stated that she does so because “it benefits them because of the isiZulu being their home language and just to explain the unfamiliar context better, you find that when you explain [to] them they understand and the next time they come across the same scenario they will know.” She indicated that she feels for her learners so using code switching in the manner she does is most beneficial for them. She said, “Of course I try as much as I can to speak in a language that would be familiar to them, and not stick to the ML so much. I try to make a connection with their everyday life. I try where I can.”

I noticed that more code switching was used by Nothando in the first observed lesson than in the second. She indicated that this is a strategic approach in her method of teaching because the first observed lesson was an introductory one. When a topic is introduced, she uses isiZulu so that the learners can familiarise themselves with the topic in their own home language. After this, English can be used to continue the learning process and consolidate the topic. Nothando said, “Firstly when on introduction I would usually lean more towards isiZulu, it’s like I build up to the English but just to make sure all of them get it because we have such a variety of learners. So, I will build it up, but I lean more towards introducing them to the topic in something more familiar to them and then try to build them up to the English.” I observed in the second lesson that Nothando read the question out in English and then repeated it in isiZulu. She explained, “I’m trying to get them to associate the two because they will be asked the same question in a test situation [and I] won’t be able to explain it in isiZulu, but you want them to make a connection between [the question and] what was taught so I’m just trying to get them [to build] that connection.”

Nothando feels that mathematics possesses its own language and that higher function questioning in ML, especially a question that requires a learner’s opinion, presents itself as a challenge. She said

that you do not just cultivate an environment to discover in a question, you require a written response, and “the language there is a challenge for most of them.” Nothando does feel that learners do comprehend the key words in a question when they attempt it, but she feels that learners struggle with cross curricular connections. A learner asked at the beginning of the lesson, “Is this data handling?” Nothando said, “You find that they do bar graphs in life sciences as well and other subjects, now when you come and tell them this is data handling, they think it is something different; they struggle with associating.” When asked how she supports the learners in the classroom when it comes to the language of mathematics, Nothando indicated that she changes the “tempo” of the lesson. She explained, “We plan our lesson and how far you go with the lesson is on how they progress, so I have to change sometimes instead of doing maybe two examples. I have to add more examples, just the tempo of teaching, the method is not a factor that much, but how fast I go is a factor.” Nothando does also feel that the ML tasks are too overloaded with complex language but, at the same time, she feels that ML’s objective is about “having to find the mathematics in the information so I don’t know what can be done about this otherwise it will be pure mathematics.”

Nothando was asked if she feels that her learners prefer questions given to them in ML are presented in written form in English on the blackboard, in a textbook, or in an examination. She indicated that before any of these, her learners prefer her to read questions to them. Nothando said, “When I read it to them, I clarify how [difficult] it will be.”

Nothando was observed writing key words on the board (see Figure 7.4). Speaking about the key words in the lesson, she said that she explained them in English and elaborated on them in isiZulu. She said that it is easier for learners to create a connection to the word if she elaborates on them in the learners’ first language. Nothando expanded on this by stating, “If you say it in English they will perhaps recall when Miss wrote that word on the board, what did she say in isiZulu?” We are creating an association, something to remind them.” When asked if she feels that her learners struggle more than first language English speaking ones Nothando indicated agreement. She said, “Being proficient in the language is an advantage in ML more especially because it’s mostly understanding.” She feels that the struggles of second and first language English speakers are different, too.

7.6 Nothando’s mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework

In this section I use the 4QCCDF as outlined in Chapter 3 to identify how Nothando supports learners when working with ML tasks. During the lessons that were observed she used ML

classroom tasks related to the instructions and contextual attributes that feature in the contextualised tasks exam paper.

Question 1 is comprised of a pie chart that represents the Grade 10 ML November 2012 examination results in terms of achievement from levels 1 to 7. Level 1 indicates that a learner has failed the examination, and the other levels indicate a pass for the examination. Question 1.1.3 (see Figure 7.5) is placed in a contextual setting with contextual signifiers, but the mathematical demands of the question are based on a one-step calculation. Question 1.1.3 is thus categorised as a Quadrant A question. Before she started working on the question, Nothando emphasised the need to understand the contextual setting. The question is based on a pie chart and Nothando made it clear that the learners must extract the required information from the pie chart. The question required learners to calculate how many learners in Grade 10 who wrote a ML examination paper achieved a level 4 grading. The mathematical information is easily extractable from the context. Here, a pie chart is used to display the Grade 10 ML examination results in percentages, so this must be used to determine how many learners of the 120 who completed the examination achieved the grade 4 level. Nothando, in a step-by-step manner illustrated to learners how to identify the information required for the task from the contextual setting. She pointed out, “But they say there 120 learners. There are 120 learners; the total number of learners is 120. How many learners achieved level 4? Level 4 is 15%. So, a total of 120 [she writes 120 on the board as she says it out loud]. What percentage of learners got level 4? How many learners achieved level 4?” Nothando moved from Quadrant A to Quadrant C by extracting the required information from the contextual setting and by displaying the mathematical calculation on the board (see Figure 7.6) in a step-by-step process in order to calculate the final answer. Nothando approached Question 1.1.5 (see Figure 7.5) which required learners to ascertain how many learners failed an examination by using the pie chart percentage to calculate this number of learners out of the total of 120 in a manner identical to what she did in Question 1.1.3, thus also moving from Quadrant A to Quadrant C.

Question 1.1.4 (see Figure 7.5) is categorised as a Quadrant A question since the task is placed in a contextual setting, but the mathematical demands of the question are based on a one-step calculation. The question requires learners to find the percentage of learners who achieved a level 3 result and a level 2 result and display these percentage results in a ratio in its simplified form. Nothando extracts the two pieces of information that represent the mathematical information to complete the task. Nothando said, “Did you see level 3? 40%, so we are writing a ratio of level 3 to level 2, level 3 to level 2. Level 2 is 20%, as I was telling you. Level 2 is 20%. Copy it over.” Nothando also placed emphasis on the mathematical rule that is entrenched in the contextual setting by saying, “Write the ratio in a simplified form.” By removing the required information from the

contextual setting, Nothando completed the computation on the board (see Figure 7.8) in a step-by-step manner, thus making the calculation of the mathematical demand a one-step calculation. This is a movement from Quadrant A to Quadrant C. Nothando further continued to consolidate learning for the learners by using a comparison of a familiar contextual setting in order to have them gain a further understanding of how to present their final answers in ratios in a simplified form and in the correct format. Nothando explained, “Ratio doesn’t have units. Don’t use units. An example is a ratio of boys to girls, ratio is written in numbers of boys to girls, and you do not write boys to girls, just the numbers. If you can say ratio 15 boys, 17 girls, we say 15 to 17 [with] no units.” In this way Nothando supported the learners in relation to this question, placed in Quadrant A, by staying in Quadrant A by using an alternative contextual setting.

Question 3 is based on the recorded cumulative number of Covid deaths in two cities in South Africa. The question has a complex contextual setting, a task introduction paragraph with a text that is lexically dense. The data is presented in a cumulative bar graph and a table. Learners needed to determine when to collect data from which source for each question. Question 3 (see Figure 10.8) is categorised as a Quadrant B question. The task introduction to the question contains contextual signifiers that are complex in nature and dense contextual language (see Figure 10.8 and 10.10). Nothando introduced the contextual setting to her learners, and then indicated where the information can be found in this question. In isiZulu, Nothando said, “When you look on the television you see data and numbers and how many new cases there are. How many new cases are there?” For Question 3.1.3, the task was to identify on what date there was an outlier for Covid deaths in the information supplied in the contextual setting. This question is categorised as a Quadrant A question since the task is placed in a contextual setting but the mathematical term in the question needs to be identified and understood in order to extract the answer from the information given in the question. Nothando identified the mathematical term for the learners and explained the meaning of an outlier to the those who did not understand the term. Nothando guided the learners to find the required number in the contextual setting that represents the outlier for the data set. Nothando said, “It can be much bigger; it can be much smaller. Does not have to be only much bigger, it can be smaller than the rest. So, you are comparing it to the rest of the data. Are you looking at cases or deaths?” Nothando directed the learners to a day on which the death rate was extremely low, and learners identified that it must be the outlier. Nothando moved from Quadrant A to Quadrant C by supporting learners to extract the correct information from the contextual setting by informing them of the meaning of the mathematical term.

Lastly, Question 3.1.4 is categorised as a Quadrant B question. The question was challenging for the learners; it is “lexically dense” because they had to understand the mathematical term “mean” in the

question and had to work out how to extract the required information from the graph in a question with a complex contextual setting. The question required the learners to calculate the mean number of the number of new Covid cases that were reported daily in Ethekeweni.

Learners struggled in not understanding the mathematical term “mean” and its mathematical function. Nothando supported them by saying, “How to calculate the number of new cases, the sum of the value of the cases for the period of fourteen days. It is the sum of the data values divided by the number of data values. So, calculate the mean number of new cases in eThekwini for the period the above data was counted. Calculate the number of new cases.” She then extracted the information from the contextual setting for the learners when she said, “Don’t go to the wrong column. You want the new cases for Ethekeweni for the period above that were collected for 14 days.” Nothando supported the learners by completing the calculation in a step-by-step process in order to determine the correct answer for the mathematical demand (see Figure 7.9). Nothando moved from Quadrant B to Quadrant C as she removed the contextual setting for the learners and supported them in the mathematical demand that she displayed in one-step or step-by-step calculations. She also identified the mathematical term for the learners and ensured for them a clear understanding of its function to complete the question.

7.7 Conclusion

In this chapter I presented my findings on Nothando, the code switcher. I collated the data from her responses in the questionnaire, from my observation of her lessons, and my interview with her. I discussed her background and teaching environment to give an understanding of the teaching conditions and environment with which she is faced. The transcript of the lesson observed is presented for insight into her lesson. Following this, I explored her views on ML, and on the ML curriculum and its relationship with English. I considered her perspective on, and approach towards, this study’s research questions. Nothando was observed using the 4QCCDF and it was noted that she continually supported learners by identifying the contextual signifiers in questions, extracting the mathematical demands from the contextual settings, and in breaking down multi-step questioning into single-step calculations. Thus, she worked continually from Quadrants A and B in moving to Quadrant C to support learners in effectively arriving at the solution to the questions she presented in the classroom. On a rare occasion, Nothando was observed staying in the same quadrant (A) when she used the same derivation of the answer to address a mathematical rule in a different contextual setting, thus giving learners the opportunity to witness the use of the mathematical rule in another setting and thus gain an understanding of its effective use. Even though the questions Nothando gave the learners in class could be categorised into different Quadrants of

the 4QCCDF, she consistently moved to Quadrant C to support learners in the extraction of the contextual setting by simplifying the mathematical demands into one-step calculations.

Chapter 8: The Leader

8.1 Introduction

In this chapter, I present my findings relating to the participant I call Sarah the leader. I include the findings from her questionnaire, my observation of her lesson, and my interview with her. The purpose of this chapter is to present how Sarah interprets ML and her opinion on the challenges of teaching ML. I conclude with my findings in relation to how Sarah feels about English and its relationship with ML. The aim of this analysis is to determine whether Sarah believes that there are language demands associated with the learning of ML.

8.2 Background of the participant and her teaching environment

Sarah is a teacher in her mid to late-forties who teaches ML at a quintile five school in the Umlazi district. She is also the Deputy Headmistress of the school. Sarah has 25 years' teaching experience and six years' teaching experience in ML. She said that she initially taught only mathematics, but her school took up the opportunity to partake in a two-year training programme at UKZN to teach ML. Since the ML teacher had resigned from her school, Sarah took the responsibility of taking some of her classes and thus started teaching ML.

Sarah is an isiXhosa speaker and is qualified as a mathematics teacher. She displayed a feeling of neutrality regarding her proficiency in English but having observed her in a lesson and having conducted an interview with her, I felt that she was rather modest in her opinion of her own English proficiency (see Figure 8.1). Sarah was not entirely sure about which languages are spoken in the class that I observed. However, she said that the learners generally speak isiZulu, isiXhosa with some speaking Sotho as a home language. She also indicated that there are some learners, though none in the observed class, who speak French and Shona since these learners' parents originate from Zimbabwe and central Africa, but they do not express themselves at school in these languages.

Sarah gave an honest reflection of the teaching and learning that takes place at her school. I observed her teaching a Grade 12 C (third set) class. Sarah explained the difficulties she faces since this class is one that has many challenges, including disciplinary ones based, according to Sarah, on other challenges they face. Sarah said, "Because this is a mainstream school, we have learners with mild and serious learning disabilities, so we design our packages" to support learners academically. As a school they do not want to label learners since they follow the doctrines of Inclusive Education that prohibits such labelling. Sarah says, "They say we must say that learners learn at their own pace

... but clearly speaking they do have disabilities” and therefore some learners in the observed class struggled to cope with the demands of academic-based material. The school creates a package for learners to accommodate their academic needs so subjects are offered to them at the FET phase that contain content that is practical in nature, that, as Sarah says, will give them the incentive to pass.

Figure 8.1

An extract of the completed questionnaire Sarah submitted about her own English proficiency.

3.2. I am very proficient in speaking English

1 2 ~~3~~ 4 5

Comment

I am good in English

The challenge Sarah experiences in the classroom is that learners who struggle with a non-practical subject such as ML can display disruptive behaviour and refuse to make an effort in the classroom. Thus, as she explained, “It’s like you are in another grade lower than where they are because you really have to be tough and say ‘I am not going to let you go until you write.’ As a result, when I do classwork as when you observed me, I have to ensure that the answers are written down.”

8.3 The lesson transcript

Sarah was observed for one lesson teaching a Grade 12 third set class that consisted of 20 boys and nine girls. She indicated that the class was mixed between isiZulu and isiXhosa speakers. Sarah used minimal code switching because she prefers using English as the medium of instruction since it is the language in which the learners will be examined. She indicated that there were learners with learning disabilities in the observed class over and above those learners who do not speak English as a first language.

I observed distinct patterns in Sarah’s lesson. She used isiZulu to discipline learners but not to elaborate on contextual settings or determine mathematical demands. She read out the questions and was very explicit in directing learners towards the mathematical demands within the contextual settings. She was also very explicit about how she expected learners to answer questions for the final examination and illustrated this to them at every opportunity the lesson presented.

In this classroom dominated by boys, the learning environment became very challenging and disruptive, and Sarah dealt with it in a very proficient and professional manner. She was very thorough in her approach to each question; she did not rush through the questions during the observed lesson. She moved to the next examination question for revision only if she felt the class was ready to do so. Sarah used a ML, National Senior Certificate (NSC), Grade 12, 2022 Topic test as the revision material for the observed lesson. Below are extracts taken from the lesson observed.

8.3.1 Lesson observation

Sarah¹⁰: Alright we're going to start with Question 2. I'm not going to allow you to change the tone in this class today. I'm not going to allow that. Annexure 1.

Sarah: *Get it, get it. Open to the correct question.*¹¹[the learner points to the question, Sarah discusses it with him, and supports him in isiZulu].

Sarah: Get to Question 2.

The class is still settling in.

Sarah: You guys cannot be jumping, if I'm marking. I'm marking, if I'm not marking, I'm not marking. I'm marking everything. What do you want?

[Many learners respond to Sarah at the same time].

Sarah: Must I mark it or leave it? I hope that everyone is able to get full marks on these things, or [did you say] I must leave it?

In the above extract Sarah is very direct and forward in describing her intentions in teaching this class. She shows that she has high standards and expects the learners to meet these.

Sarah: The important thing is for you to read. . . Every question that's going to be asked, is going to be asked on what I've given. Question 2 (see Figure 8.2) says Megan decides to make two pineapple tarts. She uses the recipe for one pineapple tart that she found on the internet. Here is the recipe. Read the recipe; remember what I said to you. Everything about recipes is about converting. If you're able to convert, you [will] get your answers.

¹⁰ These transcripts have been lightly edited in the interests of economy and coherence.

¹¹ isiZulu translation is displayed in Italics. This is important to identify how Sarah employs code switching during disciplining and supporting learners individually in the observed lesson.

Sarah: 1×500 grams Cremora milk powder, 1×cup of boiling water, 2×397 grams condensed milk refrigerated, 1×cup of lemon, 1×12 tennis biscuits. You must know the terms that they use, half a dozen, a dozen, because these are figures they use sometimes [in exams], just to confuse you. These are the kind of words that [you] will use at home. You will say, “Go buy me a half a dozen of eggs” or “Go and buy me a dozen eggs.” You know what number we are referring to, am I right?

Figure 8.2

Question used in the observed lesson.

QUESTION 2

Megan decides to make two pineapple tarts. She uses the recipe (for one pineapple pie) below, which she found on the internet.

PYNAPPEL CREMORA TERT
Ingredients (for ONE tart)



- 1 x 500g Cremora milk powder
- 1 x cup of boiling water
- 2 x 397g condensed milk (refrigerated)
- 1 x cup lemon juice
- 1 x 12 Tennis Biscuits
- 1 x 410g mashed pineapples

Method

Dissolve the milk powder in the boiling water and refrigerate for 1 hour. Stir in the condensed milk and beat until stiff. Gradually whisk in the lemon juice and stir in the fine pineapple. Pack biscuits in a flat rectangular pie plate and pour the mixture over the top. Place in the fridge until firm and garnish with cream if preferred. Deliver a large tart.

NOTE: After finishing, the tart must be placed in the fridge for 25 minutes before it can be served.

Learners: Ja [yes].

In the above extract Sarah reads the question to the learners. She is explicitly guiding the learners to the intentions of the questions. She indicates that the question involves converting in recipes. She also emphasises to the learners that they must read the question with intent to identify the contextual setting and gain an understanding of it. She also emphasises that there are contextual demands that the learners need to familiarise themselves with. The example she used was the term dozen.

Sarah: Here is the method. The answers are also in the method [so] do not underestimate reading this because they will ask you something in that paragraph (see Figure 8.2). Remember when I encourage you, they are like your English text where they ask you to read, and they want you to answer from the text.

Sarah: It says dissolve the milk, [mix] the powder in the boiling water and refrigerate for an hour. Highlight things they've given you. They will not tell you to refrigerate for an hour if they're not going to ask you [about it]. Stir in the condensed milk and beat until stiff, gradually whisk and add the lemon juice, and stir in the fine pineapple on top. Place in the fridge until firm and garnish with cream if preferred. Delivers a large tart.

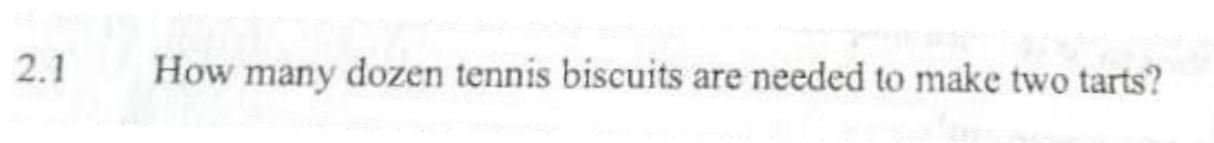
Sarah: [looks at a learner in the front of the class] Look at the note, because you are not reading anywhere. After finishing the tart, it must be placed in the fridge for twenty-five minutes so it can set.

In the above extract Sarah placed emphasis on the crucial information given in the question to help the learners complete the question successfully. This is the contextual information and the key words that can easily be neglected by learners since it is information supplied at the beginning of the question. Sarah is referring to the contextual setting of the question that gives the task information at the start of the question. Sarah asks her learners to highlight the important information and key words in the task information so as not to forget these in later stages of answering the question.

Sarah: Here are the questions now. Everything is here. Tell me that you are going to get everything correct now. First, how many dozen tennis biscuits are needed (see Figure 8.3).

Figure 8.3

Below is an extract from Question 2.1



Class: Two.

Sarah: So, a dozen is what number?

Class: Twelve.

Sarah: So, what did they say here? So, they say one times twelve biscuits, so they saying how many dozens?

Class: [Discuss between themselves what they think the answer can be].

Sarah: Half a dozen is what?

Learners: Six.

Sarah: And a dozen is?

Learners: Twelve.

Sarah: So, they are asking how many twelves?

Learners: Two.

Sarah: They say one times? [She is questioning the learners to see if they can identify that there are two sets of 12 required].

Learners: [Most say individually, two dozen].

Sarah is probing the learners to see if they can give the correct answer in order to gain full marks. All the learners are saying the number two only. Sarah is having a discussion with three boys in the front of the class regarding the question. The rest of the class is discussing among themselves how to derive the correct answer.

Sarah: So, two dozen, one dozen for the one and another dozen for the other.

Learners: Yes.

Sarah: In order for you to get two marks you must say, one dozen for the one batch and another dozen so that you can get a full two marks. Next one.

Sarah: Okay, for one tart she uses twelve, isn't it? She is going to make another tart so needs to use another twelve. So, one represents one dozen and two represents two dozen.

A learner in the front of the classroom asks Sarah an inaudible question about the presentation of the final answer.

Sarah: When you look at the question, it doesn't ask you how much biscuits cost [but] how many dozen biscuits. So, you say $2 \times 12 = 24$ [and] 24 biscuits equal two dozen. Is that clear? [You] don't give the correct answer if you don't answer what they ask [of] you.

In the aforementioned extract Sarah addresses the contextual demands in the mathematical demand by enquiring if the learners can identify what a dozen is. She explains explicitly to the learners about how to display the answer to gain full marks for the question. Sarah uses this opportunity to prepare the learners for the examination by guiding them in what and how to display the answers for the examiners. Sarah indicates something of vital importance to the class when she says, “[You] don’t give the correct answer if you don’t answer what they ask [of] you.”

Sarah: Let’s move to the next one. How many litres of boiling water is needed to make two tarts?
(See Figure 8.4.)

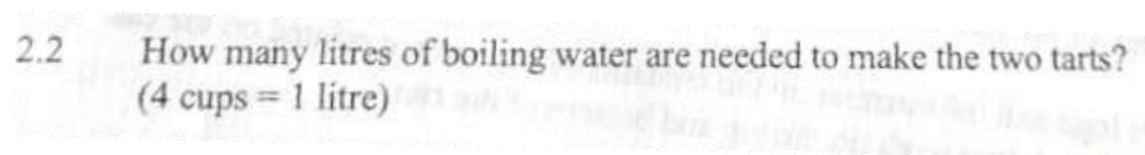
Learner: 0.5

Sarah: One cup of boiling water. That is for one tart.

Learners: Yes.

Figure 8.4

Below is an extract from Question 2.2.



Sarah: One times a cup of boiling water and they say four cups is equal to one litre [Reading from the recipe]. So what is she going to do here? She is going to make two tarts.

Learner: Convert.

Sarah: I like how you say convert, convert, but you don’t give me the conversion. One litre is equal to four cups, you see. Or four cups is equal to one litre. And then it says here, for one tart she is going to use one cup? For the other tart she is going to use one cup. So now how much? [Before calculating the required amount of boiling water needed for the recipe, Sarah is focusing on converting the cups into millilitres]

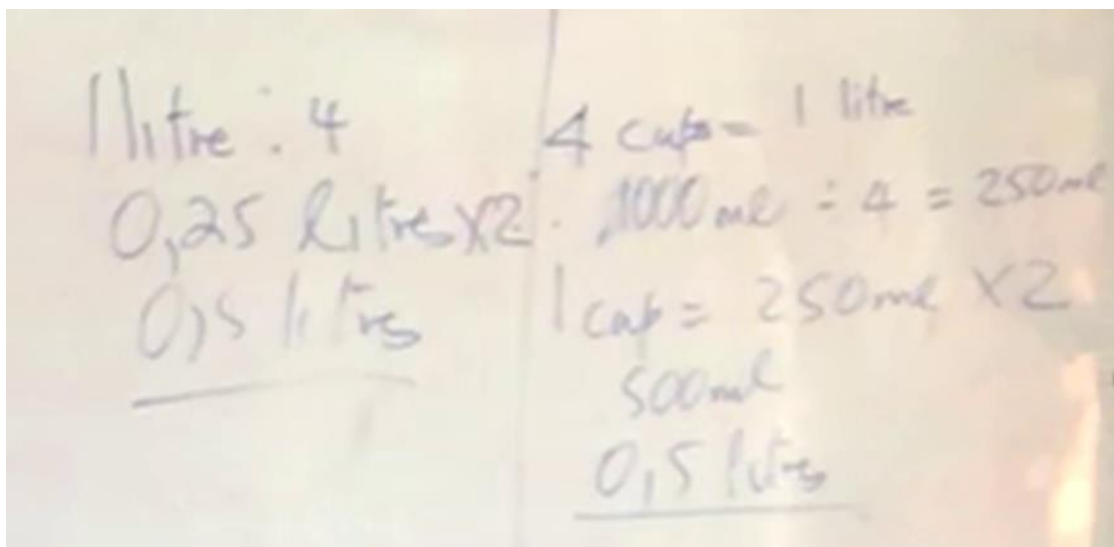
Learner: You first convert one litre to millilitres.

Sarah: OK so you [are] saying 1000 millilitres. OK. That's his method; if you have an easier way of doing it, you don't need to take this. And then? [Sarah writes the learner's descriptions on the board]. (See Figure 8.5.)

Learner: And then divide by four.

Figure 8.5

Evidence of the method used by Sarah to covert from cups to litres.



Sarah: Divide it by 4. So, you are saying each cup is equal to 250 mls.

Sarah: OK, so you want to say that one cup is equal to 250ml [Sarah writes the calculation on the board]. (See Figure 8.5.)

Learners: Yes.

Sarah: Then you say times two. Did they ask you in terms of millilitres or did they ask in terms of cups?

The class discusses it among themselves.

Learner: [speaking passionately and loudly] Convert it to litres. Convert it to litres.

Sarah: Convert it to litres. [Sarah writes the answer on the board in litres] (see Figure 8.5). If you have another simpler method as long as you understand how to do it and to convert [that is fine]. As long as you understand as well that everything that you need as an answer is there, remember when

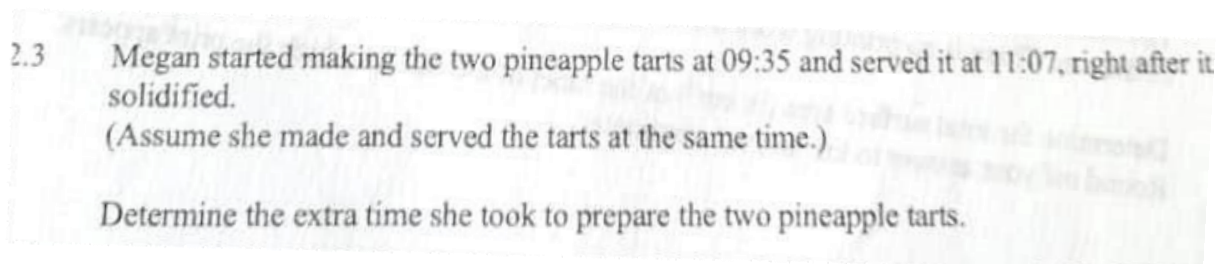
you started conversions and you were given one teaspoon, five millilitres, one tablespoon, fifteen millilitres, one cup [of liquid] 250 millilitres. If it's a cup of rice or a cup of flour, it's got another type of content in terms of units. Hasn't it? You keep to that [but] you can also use another method. Is there someone who did it differently?

The learners are working with what Sarah indicated as the link between recipes and conversion. Thus, they are being made aware of the correlation between the contextual setting and the mathematical demand. Again, Sarah uses this opportunity to show the class how to display the answer for the examiner to gain full marks in the examination.

Sarah: Alright, it says she started baking [Sarah stops reading the question and stops and stares at some learners for about 10 seconds]. I'm waiting, I'm waiting. She starts making the two pineapple tarts at 9:35 and then served them at 11:07 right after [they had] solidified. We assume she made the tarts and served them at the same time, so [this is the time] she took to prepare the two pineapple tarts. Remember the key thing that I said is that you read. [The recipe] said before you can serve them you must keep them in the fridge for one hour, [that right]? Then they said you must wait. They gave you a note [to say] it must be placed in the fridge for 25 minutes before it can be served. Is that clear? (See Figure 8.6.)

Figure 8.6

Below is an extract from Question 2.3.



Class: Yes.

Sarah: So basically, what the person needs is 1 hour and 25 minutes. So, look at the time she started and the time she finished and see if it is 1 hour and 25 minutes. Remember, I asked you before that you actually go physically, you don't have to be ashamed, and said that 9:35 to 10:35 is one hour. [Sarah refers to the counting of time where learners use their fingers to accurately calculate time]

Class: Yes.

Sarah: Then [take] 10:35 [and] calculate the minutes up to 11. So, say 10:35 you say 10:40, 45, 50, 55, 11:00, that is 25? So, one hour 25 minutes finishes at 11 [doesn't] it?

Learners: Yes.

Sarah: That is the time that she needed [to make] the tarts. So, they're [asking] how many extra minutes. They are telling you that she finished at 11:07 but she was supposed to be finished at 11 exactly if she needed 1 hour and 25 minutes.

[The class discuss the time taken to make the tart].

Sarah: So, in order for you to gain the three marks what are you writing? What are you writing in order to get the three marks?

[The class discuss how to present the answer to gain three marks].

Sarah: In seconds [Sarah answers a learner in the front of the class and the class starts laughing]. So how do you write for three marks after I explained to you how to get to the extra time? And remember you must answer the question. How many extra minutes? You must say she was supposed to be serving it at this time therefore she took this number of extra minutes. [Says to a learner, are you writing this down?]. No, you show the calculations, but you write a sentence too, to show your calculations.

Sarah: Guys, you don't need a calculator. How many times have I discouraged you to convert time using a calculator. How many times? Yes. So, let's say I'll be writing now for three marks, so what will I be writing?

[Sarah guides the learners and she writes the methodology on the board to get to the correct answer] (see Figure 8.7).

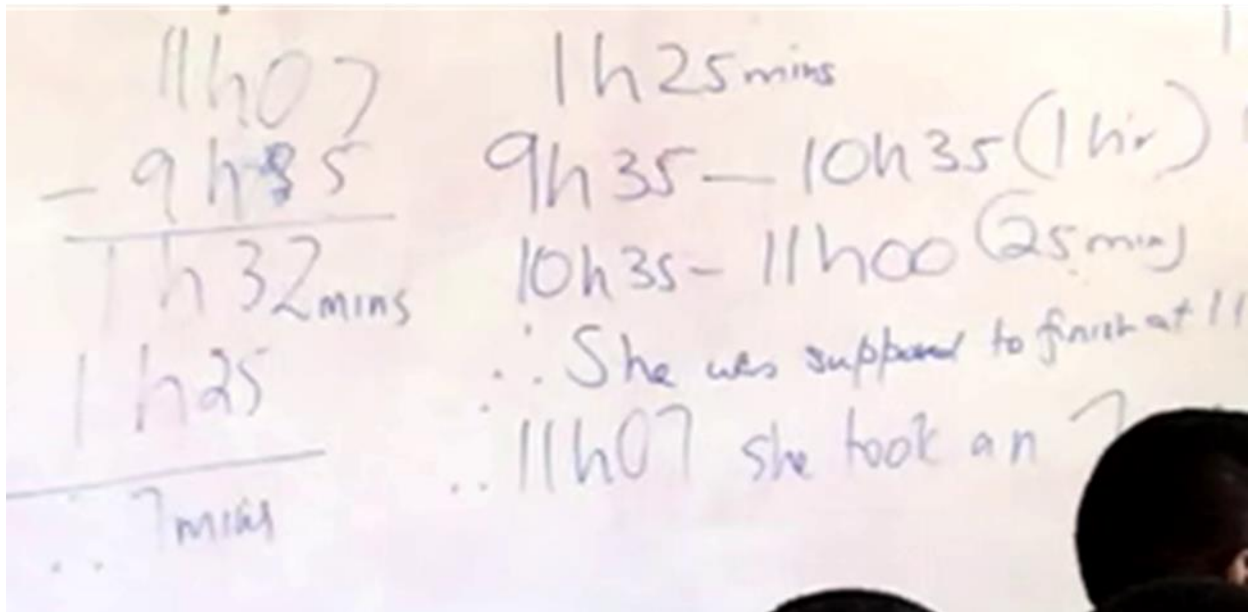
In the above extract Sarah alludes to the task information that needs to be used in order to obtain the information to attempt the question successfully. Sarah further uses the contextual setting to support the learners in answering the question by telling them not to use a calculator and to calculate time using their fingers. She writes the methodology on the board so that learners can see how to gain full marks.

Sarah: Let's go to Question 3. This is formula of interest, right? Read the question; this is the one we are interested in. This question is always poorly answered because most of the time you run away from anything regard[ing] measurement using formulas and substituting them. even right now

as they provide you, even right now when they provide... *If you do not keep quiet¹²*, in two minutes I will send you out, I'm telling you, try me again.

Figure 8.7

Evidence of the method used by Sarah to conduct a time calculation.



Sarah: Before you answer the question, you must analyse what they have given [about] the can. They have given you the diameter of the can. There is no radius value, but all of you at this stage are able to find the radius? We spoke about that in our last question, we said that radius is what?

In the above extract Sarah uses isiZulu to discipline learners, but not to explain mathematical concepts. She gave the learners an explanation of the contextual setting before reading the question to the class. Sarah did this so the learners can familiarise themselves with the contextual setting and this creates the opportunity for the learners to then identify the mathematical demands of the question.

¹² This was said in isiZulu.

8.4 Views of Mathematical Literacy and the curriculum

Sarah views ML as a subject that consists of mathematics as its core component and that integrates other subjects into its subject matter. She said, “ML equips learners to have a qualification related [to] mathematics, [and] integrates other subjects.” She supported this by indicating that learners need a great deal of subject knowledge to be successful in ML so this subject needs to be approached differently by teachers in the classroom in comparison to teaching mathematics. Sarah said, “Accounting, geography, English and mathematics are needed and the approach to teaching ML is different to mathematics.” There were three threads that arose from Sarah’s views of ML and the curriculum Likert scale questions in the questionnaire (see Figure 8.8). The first thread was Sarah’s strong agreement with the pace of the curriculum. She indicated that she strongly agrees with the pace of the ML curriculum (another five of the 32 respondents agreed with her) and strongly agrees that the ML curriculum can be completed in an academic year (another 11 of the 33 respondents strongly agreed with her). Sarah also agreed that learners should be taught the mathematical content before the real-life context is introduced (another 12 of the 33 respondents agreed with her).

The second thread refers to Sarah’s mostly positive views of the curriculum content itself. She is very satisfied with the current topics in ML. She strongly agreed with the necessity of the topics of ML (another nine of the 31 respondents agreed with her), that the curriculum is well suited to achieve the purpose of ML (another five of the 33 respondents agreed with her) and that the sequencing of the ML topics according to CAPS makes sense (another 14 of the 33 respondents agreed with her). Sarah strongly disagreed that ML needs more topics such as algebra and geometry (another 14 of the 33 respondents strongly agreed with her).

The third thread relates to Sarah’s strong agreement about the importance of the real life demands and expectations in ML. She strongly agreed that ML learning supports learners dealing with real life problems (another nine of the 33 respondents agreed with her) and that ML supports learners to solve real life problems (another 18 of the 33 respondents strongly agreed with her) (see Figure 8.8).

Figure 8.8

Below is an extract from the completed questionnaire Sarah submitted about her opinions about ML.

Using the following scale of 1-5, use a number to indicate the degree to which you agree with the statements listed below, where

1	2	3	4	5
Strongly disagree	disagree	Neutral	agree	Strongly agree

- 2.3. I am pleased with the pace of the ML curriculum 1 2 3 4 ~~5~~
- 2.4. I am able to complete the curriculum each year 1 2 3 4 ~~5~~
- 2.5. All the topics in the ML curriculum is necessary 1 2 3 4 ~~5~~
- 2.6. The ML curriculum needs to include more topics, for example algebra & geometry ~~1~~ 2 3 4 5
- 2.7. The ML curriculum is well suited to achieve the purpose of ML 1 2 3 4 ~~5~~
- 2.8. The sequencing of the ML topics according to CAPS makes sense 1 2 3 ~~4~~ 5
- 2.9. I believe that mathematics learning helps learners to deal with real-life problems 1 2 3 4 ~~5~~
- 2.10. I believe that ML is necessary because it will help learners solve real life problems 1 2 3 4 ~~5~~
- 2.11. In Mathematical Literacy, learners should first be taught mathematics content and then taught to deal with real life contexts 1 2 3 ~~4~~ 5
- 2.12. A teacher needs a strong mathematical background for effective teaching of Mathematical Literacy 1 2 3 ~~4~~ 5

Any comment

Most learners who have a mathematics and English understand generally do well in ML of course here has to be mathematics understanding as well

Sarah further identified that there are certain struggles that arise from the ML curriculum. When I asked her if she feels that mathematics has its own language, she indicated that ML does not

necessarily have its own language. She said, “It has stolen from accounting, hospitality, geography, [and] from mathematics.” Sarah elaborated on this.

If you have got a bit of an understanding, which is an advantage, that if you teach ML, there’s got to be one learner who does geography, scale and map work, accounting for cost production, profit etc., but these are tough topics [for the other learners]. If there is one learner doing hospitality . . . they can talk about recipes and talk about the language of hospitality. So there is no ML language, it is [made up of] a language from all the different subjects it has stolen from— [a] bit of mathematics, accounting, geography and English, because data handling is a mathematics topic, profit loss and sales is [from] accounting, then you’ve got scales and map work (which they don’t like) that is from geography, then you have measurement [which] is mathematics.

Further to this, Sarah indicated that the resources to support learners in ML that [includes] textbooks and resource material is limited and not relevant, especially when it comes to the examination of learners by the DBE. Sarah said, “What I use as a textbook is not enough for me to prepare them for the exam. Because the paper comes, and it [refers to the] same measurement but they don’t ask it in a way similar way [to how] we do it in the exercise.” Sarah indicated that it is vital to do examination preparation for Grade 12 learners, such as the lesson I observed in which learners completed past examination paper questions as preparation for the final examinations. Sarah said, “The day you came, we took out a question [on a] recipe on [a] question paper, so they can get used to reading and [I] make them read all the time [so] they can get used to writing properly for full marks.”

Sarah continues to identify struggles with the ML curriculum since she experiences contextual overloading in it. In connection [with] the recipe question calculations, Sarah noted that the learners in the class all chose Hospitality as one of their FET subject choices and thus were familiar with the context of the question. I asked Sarah if she feels that one needs to teach learners more than just mathematics in a ML lesson. Sarah responded that if she [is] not in the classroom for even five minutes, she expects the learners to cope with the work set since she attempts to set work on contexts with which the learners are familiar. Sarah said, “We do our graphs using cell phone contracts. When I teach that topic, I tell them that they all have cell phone prepaid contracts involving minutes and messages [so they] should be able to answer whether I’m there or not.” Sarah gave another example in saying, “If [the question is] about transport tariff, [they are] using Ubers [so they] know that the tariff here means that once you move it [costs this much], but if you are

taking a hired car, some say [you pay for] kilometres [driven] and some are saying [you pay] money plus [the cost of] kilometres.

When I asked her how she supports the learners in contextualisation Sarah said that one must give the learners contexts that they are used to. For her, you can make context an advantage when the contexts given are known to the learners. Sarah said that learners who come from Core Mathematics laugh, thinking that ML is easy. She warns these learners that they have not been exposed to the contextualised questioning in ML. She says to her ML learners,

Don't worry about people laughing at you as they come here they will realise that it is tough. Just know that you are advantaged [because] you are doing something very contextualised. Cinema seats are contextualised; there is a seating plan, [you] sit according to a seating plan. You have a seating plan when you sit in matric [so] how can you get that wrong? Schedules, like a time schedule, is another topic. [I tell them] 'You have flown in a plane, or [been in a] bus before, so you are able to look at these things. Every topic of yours is contextualised.'

When I asked Sarah further about contextualisation, she said,

They are going to ask you questions [about] the total surface area [and will ask] about how much material is needed. They will phrase it like that. They will be talking about boards [and about] how much material is needed to make this kind of box. The only thing that you must know is that in this question, [you] answer [about] the total surface area.

When I asked her about this statement in the interview, Sarah indicated that ML is so contextualised that "even when you talk about [a] box, I'm thinking of packaging. Packaging, where we talk about the packaging of tins in [a] rectangular box . . . you need to visualise. The amount of wasted space depends on the number of diameters you can lay on the breadth and the width. When you say to learners, 'Visualise . . . you can only put four and seven on these sides and three on top, so then you multiply four by seven by three to calculate the volume, it's just hard.' Sarah revealed in the interview that she consistently tells her learners that they will not escape topics such as conversion, area, measurement, and packaging. She said [that she tells her learners], 'Like it or not, please help me visualise. Think of a shelf at ShopRite,¹³ think of something where you are packing [like] apples in a round box. At least in a round box, there will be minimum wasted space, but in a square box you will have lot of wasted space since you will have so many gaps in between.' Sarah indicated that learners need to understand the context and link it to their real world experiences. As she says,

¹³ ShopRite is a retail supermarket.

her learners have packed things before, and many learners have moved house before. So, they need to use this real life experience and submerge it into context to solve the questions in the classroom.

8.5 English and its relationship with Mathematical Literacy

Sarah is an isiXhosa speaker who teaches in English and reprimands in IsiZulu because she finds that disciplining in English is not effective. The learners can distinguish the language used in relation to its intent. Sarah stated that if she disciplines in IsiZulu, you can adapt the language and make the learners understand that they need to follow instructions. Academically, Sarah supports the notion of teaching in English as the medium of instruction but offering minimal support in code switching can be useful to them. She said,

Code switching can be useful because, [for] some of them when you say ‘Read’, you understand that they are challenged with their reading. They don’t understand so they laugh at each other, and it becomes a joke, so it is important for me to continue dealing with them in English but also try to emphasise [discipline] in the language they understand.

Sarah indicated in the interview that how she chooses to use the language of instruction in her classroom practice is very important because “the emphasis of your language is very important for learners to take you seriously.” Since English is used as the medium of instruction, learners know [if] learning needs to take place . . . attention needs to be given to [listening to] her. She also feels that there is an advantage for those learners who “have a clear understanding of English.” Sarah also said, that “there is the mathematics part of it [and] if you are not inclined mathematically, you are not going to make it.”

Sarah also indicated that in her teaching career she has witnessed learners with learning disabilities struggle with the language complexities of ML. In relation to the complexities of the ML language, Sarah indicates that in the examination of ML, it is not necessarily the language of the examination papers that is a stumbling block to the learners, “but the depth of the paper [in] being tricky is the problem.” For her, language and context are not the problem; “they can still see [for example] that you are talking about cell phone tariffs here or transport tariffs.” Rather, the [problem is that] questions are sometimes presented in a tricky manner. She supports this statement by indicating, “It is a little tricky for them to understand that I’m still doing the same tariffs as I’m doing in class, I’m still doing VAT, water tariffs, but how the examiner puts it is not as clear as how the learners understand or remember it.”

Sarah was presented with an excerpt from the lesson observed:

Sarah: It says dissolve the milk (mix) powder in the boiling water and refrigerate for an hour. Highlight things they've given you. They will not tell you to refrigerate for an hour if they're not going to ask you [about this]. Stir in the condensed milk and beat until stiff with the whisk and add the lemon juice.

(I can't hear clearly but she keeps reading the instructions to make the tart.)

When you look at the question it doesn't ask you how many biscuits it cost, [but it does ask you] how many dozen biscuits so if you say $2 \times 12 = 24$, you then say therefore, 24 biscuits equal to two dozen. Is that clear? Don't give the correct answer but you don't answer what they ask you."

Sarah was asked if she feels that learners find ML easy or difficult when they face the examinations that are written in English.

Sarah responded by indicating that the language of the examination is the fear. The context and work set in the lessons are not too far removed from how it is examined. She said, "It is the same context, it is the same language it's just some of the things are hidden a little bit for them and they don't want [to] read and delve in."

When asked how she supports learners who are struggling to understanding the written work in ML, Sarah said that she supports learners as much as she can during lessons in order to monitor their progress. She said, "I am tough and playful in my lessons, I want to reach everyone, and I am also walking around in between them, just to have my eye on what they are writing." Sarah indicated that as she monitors the learners and walks between them, she pays attention to who is writing and who is not. If a learner does not write an answer down, she will support that learner. She places great emphasis on writing in her classroom.

I know them, so as I walk around as they are writing, I keep my eye on them. I sort of assist, in terms of saying, 'This is what we are saying, this is what we are doing, write.' [I] encourage them, that little part, and say, 'Write it down. If you write this down, if you understood that this is 78 of the total length of the chair, write this down. In order for us to find the π , radius, length of the chair, you say minus the one part, at least write this part down, you can struggle later.' I'm sure that things can be written down."

Sarah further indicated that at Grade 12 level, learners are struggling with ML in her school and in South Africa in general. She believes that if she writes the methods down on the board and the learners copy down her methods, this will guide them as to what is required of them to succeed in the examination. Sarah said,

[In relation to] what I said should be written down, yesterday we were doing quantities of material, so we were trying to figure out how much plywood was used [to make] this seat and how much aluminium was used. I have to write it down in order for it to be written down [by learners] otherwise it is difficult. This is [what] I want you to see, and this is ML in Grade 12. I have so many learners who I have to sit on who are still not able to pass. So that's the tough [part] you see. [It] is the lack of academic ability.

I asked Sarah why she places so much emphasis on the reading of the questions. She indicated that ML gives you an advantage because you are given a question where the information is in a passage of words. You need to extract the information from this passage. Therefore, accurate reading skills could be advantageous for learners. Sarah said,

Because you know that in ML they have so much advantage because they are always given a passage and they are always given an addendum. I always say to them, 'When you get to [a] question, treat [it] as English literature or as an English comprehension [passage]. There is no way that in this paragraph there is no answer, so [my] emphasis [is on] reading [especially for] certain classes. Once they get to the exam, they look and pretend that they are reading [but] when we get to class to do the corrections, [I ask], 'Did you not see that the answer was here? [They reply], 'No mam.' [So I ask] 'But why did you not read? Everything is about reading.'

8.6 Sarah's mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework

In this section I use the 4QCCDF as outlined in Chapter 3 to identify how Sarah supports learners when they are working with ML tasks. During the lessons that were observed she used questions taken from a previous examination paper.

Question 2 (see Figure 8.2) is a recipe for making a pineapple tart. The question consists of a list of ingredients with the quantities required of each ingredient, the method of making the tart, and contextual signifiers. This question involves a complex contextual setting and dense contextual language. Before approaching the first question, Sarah instructed the learners to highlight the key phrases and key words in the introduction to the question to help them identify the mathematical demands in the contextual setting of this task. Sarah noted, "It says dissolve the milk, [mix] the powder in the boiling water and refrigerate for an hour. Highlight things they've given you. They will not tell you to refrigerate for an hour if they're not going to ask you [about it]." Sarah was thus

supporting learners in having them identify signifiers, key mathematical terms, and mathematical demands in the question as a way of helping them to respond to such questions in the future.

The first task is Question 2.1 (see Figure 8.3) to be inserted into the 4QCCDF is one that is considered to be a Quadrant A category question. The question required learners to determine how many dozen tennis biscuits are needed to make two tarts. Sarah supported learners in this question by identifying the signifier being the term dozen and explaining what this signifier represents. Sarah asked, “So, a dozen is what number?” She identified that learners need to understand the signifier to complete the task successfully. She then illustrated to the learners how to compute the one-step mathematical demand of the task. She thus moved from Quadrant A to Quadrant D by identifying the mathematical demand through the identification of the signifier and solving the calculation with the learners by extracting the contextual setting, defining the terminology, and reducing the mathematical demand to a one-step calculation.

Question 2.2 (see Figure 8.4) is categorised as a Quadrant B task. It contains a contextual signifier that needs to be identified and understood within the complex contextual setting. The question required learners to identify how many litres of boiling water is required to make two tarts. The mathematical demand of the task is also a multi-step problem situated in a dense contextual language setting. The amount of boiling water used to make a tart was given in the list of ingredients in a cup measurement. The term cup has a specific use in this contextual setting and possesses a special meaning here. Sarah started by illustrating how to derive the answer to the amount of liquid one cup contains in millilitres (see Figure 8.5). She showed the learners how to solve the problem presented by the signifier within the contextual setting as shown below.

Sarah: OK so you [are] saying 1000 millilitres. OK. That’s his method; if you have an easier way of doing it, you don’t need to take this. And then? [Sarah writes the learner’s descriptions on the board]. (See Figure 8.5.)

Learner: And then divide by four.

Sarah: Divide it by 4. So, you are saying each cup is equal to 250 mls.

Sarah then concluded by illustrating to learners how to solve the mathematical demand by extracting the contextual setting (see Figure 8.5). She moved from Quadrant B to Quadrant C by determining the contextual signifier in the task, extracting the required information from the contextual setting, and then working out the mathematical demand in a one-step calculation to solve the question.

Lastly, Question 2.3 (see Figure 8.6) is categorised as a Quadrant B question given its complex mathematical demand and also because it contains a contextual rule. Sarah placed emphasis on the

contextual rule to support learners by showing them its applicability in the calculation of the mathematical demand of the task. The question required learners to identify how much longer it took a person to make two tarts when she or he started making the tarts at a specified time. The information given in the introduction to the question is used because this is where the instructions about how to make a pineapple tart are placed. The mathematical demand of the question can be solved by calculating the time it takes to make a pineapple tart and have it set. So, learners were required to determine, using the recipe as methodology, how much extra time is needed to prepare two pineapple tarts. Sarah read through the methodology of preparing the tarts, placing emphasis on instructions and the contextual rules of the recipe. She pointed out, “Then they said you must wait. They gave you a note [to say] it must be placed in the fridge for 25 minutes before it can be served. Is that clear?” She supported the learners in the task of determining the time it takes to make two tarts. Sarah said, “So basically, what the person needs is 1 hour and 25 minutes. So, look at the time she started and the time she finished and see if it is 1 hour and 25 minutes. Remember, I asked you before that you actually do this physically, you don’t have to be ashamed, and we said that 9:35 to 10:35 is one hour.” She motivated learners to use their fingers to count the time and not to rely on calculators for this. Sarah concluded the work on this question by having learners determine the extra time it took to make the extra tart by removing the contextual setting and having them make the final calculation. Sarah moved from Quadrant B to Quadrant C by supporting learners in extracting the contextual setting from the mathematical demand, determining the answer, and then adding the contextual rule to answer the question successfully in a step-by-step manner, thus breaking the calculations down into manageable one-step calculations (see Figure 8.7).

8.7 Conclusion

In this chapter I presented my findings on Sarah the leader that I collated from the data collected in her replies to the questionnaire, from my observation of her lesson, and from the interview findings. I discussed her background and teaching environment to give some understanding of the teaching conditions and environment with which she is faced. I present the transcript of the lesson for insight into this lesson. Following this I explored Sarah views on ML’s curriculum and its relationship with English in the light of her view on the English reading and writing skills of her learners to determine her perspective on, and approach to, this study’s research questions. It was noted that Sarah continually supported learners by identifying the contextual signifiers in questions, identifying the contextual rules in the contextual settings, extracting the mathematical demands from the contextual settings, and breaking down multi-step questions into single-step calculations. Thus, the questions Sarah gave to learners ranged in the 4QCCDF in Quadrants A and B, but

Sarah's strategy was to move to Quadrant C by supporting learners in effectively arriving at the solution of the question presented in the classroom by removing the context, implementing contextual rules in questions where necessary, and simplifying the calculations. Even though the questions Sarah gave the learners in class could be categorised into different Quadrants of the 4QCCDF, she continually moved to Quadrant C to support learners in the extraction of the contextual setting and in simplifying the mathematical demands into one-step calculations.

Chapter 9: The Kind One

9.1 Introduction

In this chapter, I present the teacher I have chosen to call Bridgette the kind one. These include the findings from Bridgette's questionnaire, from my observation of her lesson, and from my interview with her. The purpose of this chapter is to present how Bridgette interprets ML and her opinion on the challenges she faces in teaching ML. I will conclude with the findings on how Bridgette feels about English and its relationship to ML. The aim of this analysis is to determine whether Bridgette believes that there are language demands associated with the learning of ML.

9.2 Background of the participant and her teaching environment

Bridgette is a female teacher in her early forties with a PGCE and 10 years' teaching experience. She speaks English as a first language. She teaches in the Umlazi District in central Durban and is based in a SEN school. The school accommodates physically disabled learners with academic ability. Bridgette indicated that she has experience in teaching mathematics at primary and secondary level, including teaching Core Mathematics and ML. She said, "I have taught Grade 5 right up to Grade 12. So, I have had the experience of [teaching] all the different phases [in] all the different grades, so it is very easy for me to tell where their gaps are and then ask them, 'Do you remember this?' to bring them up to the level where they need to be, so that helps."

Bridgette was very calm and was kind to her class in displaying a positive attitude towards the learners and was most accommodating of their SEN needs. She said that learners in her school are sometimes absent because of illness and medical appointments so she set up a WhatsApp group for the learners' parents. She takes photos of work completed on the board during the lesson and sends these to the parents of absent learners to promote their supporting work completed by these learners at home.

Bridgette indicated that the challenge she faces in her classroom environment concerns learners "who are blind [since] they are at a real disadvantage in terms of ML being so visual and in terms of the maps, the shapes, measurement, and things like that. The work is rarely adapted for them and although we do adapt it, they kind of miss the plot of actually going through and researching it for themselves." Bridgette noted that the DBE does not support learners who are blind with any resources since they issue brail papers only for the Grade 12 common papers and the final examination. Thus, from Grade 10 to 11 the blind learners cannot prepare sufficiently for ML

assessments since the resources are so limited. She uses the common papers to give blind learners some experience in examination settings, and said, “So all that I do is common papers with them as revision in class. They don’t know how the department is actually going to adapt [the examination] for them. The only [learner] we had who was blind was the one we had last year, so yes, we had that challenge.”

Figure 9.1

An extract from the completed questionnaire Bridgette submitted on her thoughts about teaching the mathematics content before teaching the real-life context.

2.11. In Mathematical Literacy, learners should first be taught mathematics content and then taught to deal with real life contexts 1 2 3 4 5

Another challenge Bridgette faces in her classroom environment is that the learners lack foundational mathematical skills, so when they move into a ML class, these skills need to be developed first (see Figure 9.1). She also faces language barriers. She said, “Because English is like a second language to most of them, understanding and comprehending the questions is where they struggle. This is especially so with the high-level questions. For them to actually understand what these are asking of them is the challenge.”

9.3 The lesson transcript

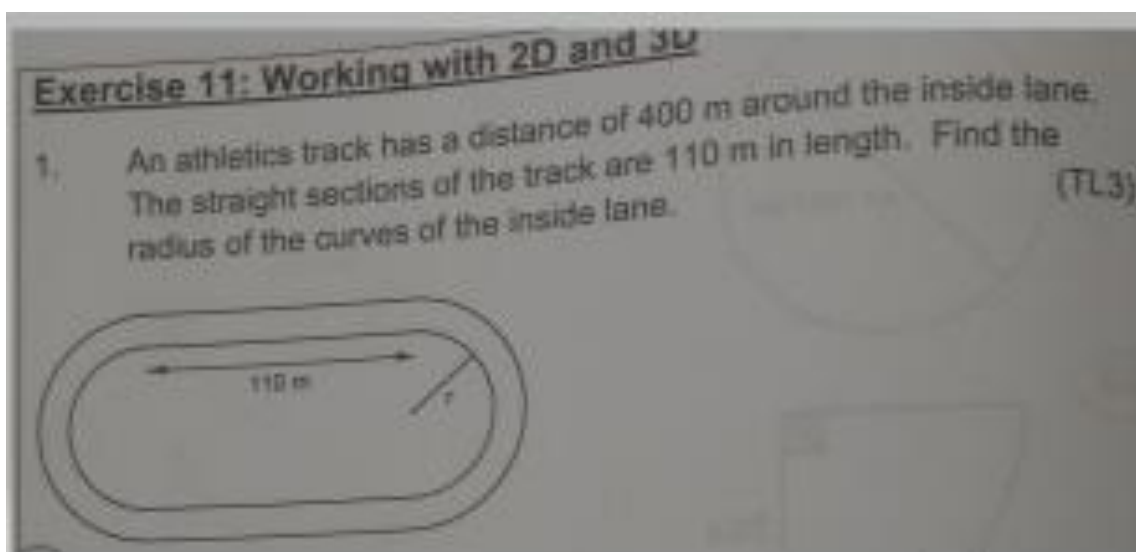
I observed two of Bridgette’s lessons in a Grade 11 ML class that was revising for their June examinations. There were 12 learners in the class. Bridgette indicated that the class was a mixed ability class consisting of learners who spoke isiZulu, isiXhosa, and English. For religious reasons, one learner was studying Arabic. Bridgette herself is an English home language speaker and thus taught the class using only English as the medium of instruction.

I observed distinct patterns in Bridgette’s lessons. She used every opportunity to have learners read out the questions to promote literacy in her lessons. For every question Bridgette provoked discussion with the learners to identify their understanding of the question in terms of contextual setting and mathematical demands. She also identified any learner’s misconceptions in relation to their mathematical skills and addressed these instantly. She did not rush through the questions and wrote the methodology on the board for each one to promote mathematical understanding with her

main objective being to show her learners how to present answers in the examinations. Below are extracts taken from the two lessons observed.

Figure 9.2

Question from the textbook that was used in one observed lesson.



9.3.1 Lesson observation

a) The first observed lesson

Bridgette¹⁴: Unathi, can you read the first question? (See Figure 9.2.)

Unathi: An athletics track has a distance of 400 meters around the inside lane. The straight sections of the track are 110 meters in length. Find the radius of the curves of the inside lane.

Bridgette: OK, what is this question asking of us, boys and girls?

Learner: To find the radius.

Bridgette: To find the radius of what?

Learner: The curve of the inside lane.

Bridgette: The curve of the inside lane, and what information have they given us already, Mpilo?

¹⁴ These transcripts have been lightly edited and shortened in the interests of economy and coherence.

Mpilo: That the athletics track has a distance of 400 meters, and the straight section of the track is 110 meters in length.

Bridgette: OK, so how do we go about answering this question?

There is a silence in the classroom.

Bridgette: What do we find first?

A learner in the class raises her hand.

Bridgette: Yes.

Learner: You subtract 400 from 110 meters.

Bridgette: No. Anybody else.

Learner: What page are we on?

Bridgette: Page 160, exercise 11.

Bridgette: In order to find the radius, what do we need to know?

Learner: Diameter.

Bridgette: The diameter.

In the above extract Bridgette selects a learner for each question and makes the learner read out the question to promote literacy in the classroom and to promote learner engagement. Bridgette asks learners probing questions throughout the lesson to determine if they understand and are familiar with the contextual setting. She then further asks probing questions to determine if the learners can identify the mathematical demands in the question and if the learners have the knowledge to solve the question using the mathematical skills correctly.

Bridgette: 400 minus 220 is?

Learner: 180.

Bridgette: And what is the unit of measurement?

Bridgette: Now we know the perimeter of the circle (it is called the circumference). Now, circumference, C equals $\pi \times \text{diameter}$. From the diameter we can get our radius, thus 180m equals.

Bridgette: How much is π ?

Figure 9.3

Evidence of the method used by Bridgette to calculate the radius.

Handwritten calculations on a chalkboard:

$$\begin{aligned} 1. \text{ Per cycle} &= 400 - (100\pi) \\ &= 400 - 314 \\ &= 180\text{m} \\ C &= \pi \times d \\ 180\text{m} &= 3.142 \times d \\ 180\text{m} &= d \times 3.142 \\ 57.29 &= d \\ 57.29\text{m} &= r \\ &= r \end{aligned}$$

Class: Meters.

Learners: 3.142.

Bridgette: $3.142 \times \text{diameter}$, equals...? [The class is silent] We need to take π to the other side of the bridge to solve diameter.

Bridgette has substituted the values into the rule and has explained how to complete the calculation (see Figure 9.3).

Bridgette: And when I take it to the other side of the bridge what can I do with the operation. I do the opposite [the class say the word opposite with Bridgette].

Bridgette: 180 divided by 3.142 equals diameter. Can you divide that and tell me what answer you get? [Learners use their calculators to obtain the answer]. Do you also get 57.29?

Learners: Yes.

Bridgette: Rounding to two decimal places.

Bridgette: That will be in meters.

Learner: It is the diameter.

Bridgette: Now to get the radius, divide by two. 57.29 divided by two gives you an answer of 28.64m.

Bridgette: Who got this question correct?

[One learner responded]

Learner: I did.

Bridgette: That's good. The rest of you, partially right?

Learners: Yes.

In the above extract Bridgette displays to the learners on a step-by-step basis how to display the answer correctly for examination purposes. She also keeps referring to the unit of measure and asks the learners frequently what measure of unit is used in the questioning to determine if the converting of units is required.

Bridgette: Siyabonga, can you read Question 2 for us?

Siyabonga: Burglar bars for a window [are] to be made as shown in the diagram below. Calculate the total length of metal that will be used to make the burglar bars, correct to the nearest centimetre (see figure 9.4).

Bridgette: What is that question asking of us? What is it saying to us? Siyabonga? [Siyabonga does not respond.] It is saying to us that we need to find the length of the metal. Good, so we are looking at the entire length of the metal, and what unit of measurements will we be using?

Learners: Centimetres.

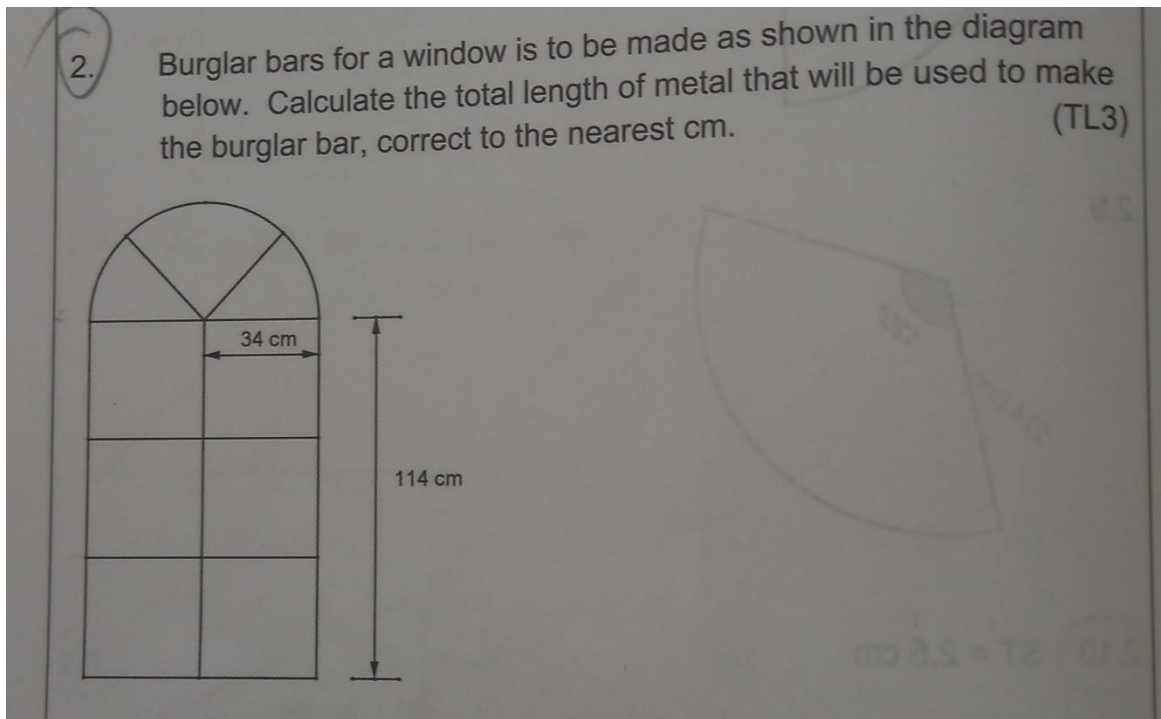
Bridgette: Have they given you the measurements in centimetres already?

Learners: Yes.

The above extract is another instance in which Bridgette guides the learners through the contextual setting in order to determine the mathematical demands and mathematical skills required for this question. She guided the learners using a step-by-step approach.

Figure 9.4

Question from the textbook that was used in the observed lesson.



Bridgette: Who is going to read number 3? Anyone?

Learner: Grade 11 Mathematical learners had a project to make 3-dimensional shapes. Determine the volume and surface area of the prisms which they constructed (see Figure 9.5).

Bridgette: What does this mean, learners? Anyone? Luyanda?

Luyanda: To calculate the surface area of the object.

Bridgette: The surface area, good, and what else are we finding?

Luanda: The volume.

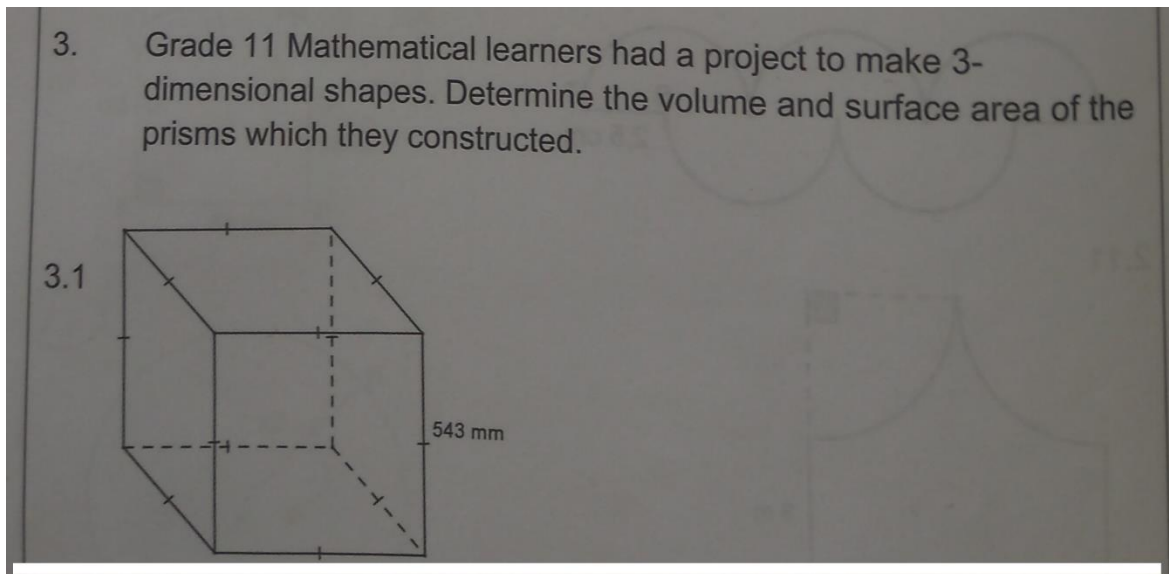
Bridgette: So, the first shape that's there, alright, what shape is [it]?

Learners: A cube.

Bridgette: How do we know that it's a cube?

Figure 9.5

Question from the textbook that was used in the observed lesson.



Learner: It has six sides.

Bridgette: It has six sides, OK, that is one reason [and] what do we know about the six sides?

Learners: All are equal.

Bridgette: So, they have given us the measurement there, OK. So let us find the surface area of the cube [Bridgette draws the cube on the board]. Who knows the surface area formula of a cube?

Learner: $S^2 \times 6$.

Bridgette: $S^2 \times 6$. good [Writes $S^2 \times 6$ on the board and asks the class] What is the value for S. 543 millimetres, and we square that and multiply by 6. So do that for me [Bridgette writes the calculation on the board]. What answer do you get?

Learner: 294 849

Bridgette: Multiply by 6.

Learner: 976 094.

Bridgette: That is not correct. [Bridgette asks another learner to help].

Learner: 1,769 094.

Bridgette: And our unit of measure is millimetres. [Bridgette walks to the board to write the answer on it].

Bridgette: What is the next thing that we are going to be looking at?

Learner: To check the volume of the cube.

Bridgette: To find the volume of the cube. How do we find the volume of the cube? Yes Siyabonga?

Siyabonga: Side $\times$ 6.

Bridgette: No. Anybody else? OK let's look at the volume of a rectangle. The volume of a rectangle is length $\times$ breath $\times$ height [the learners say 'length $\times$ breath $\times$ height' together with Bridgette].

Therefore, the volume of a cube will be side $\times$ side $\times$ side which is side cubed [Bridgette writes S^3 on the board.] What is the value of a side?

Bridgette: 543^3 . [She writes this on the board] And what do you get. What is your answer? Yes, Unati?

Unathi: 160 103 007 [Bridgette repeats the number and writes it on the board].

[Bridgette took a photo of the work on the board later sent it to the absent learner whose mother will assist him in the work at home].

In the above extract Bridgette displays how she supports the learners in establishing the key words in the question such as volume and surface area, and determining the mathematical demands that present themselves in the question. She continually supports the learners by displaying the methodology that is expected of them in answering such questions in the examination on the board (see Figure 9.5). Bridgette further supports an absent learner by having the work on the board (see Figure 9.5) sent to his mother.

b) The second observed lesson.

Bridgette: Did you get a chance to look at exercise 12 at home?

Learners: Yes.

Bridgette: How was it? Was it a challenge? Was it easy, was it medium, was it difficult?

Learner: It was medium.

Bridgette: Medium on this end, and on this end? [looking at the other side of the classroom but there is some silence]. Who says it was challenging?

[A few learners raised their hands to indicate that it was challenging].

Bridgette: Who says it was easy?

Learners: No.

Bridgette: So, let's work on it. Before we start, I hope you all have your revision with you. Who does not have their revision?

[One learner raises his hand and indicates that he does not have his revision with him].

Bridgette: Did you copy it from any of your friends?

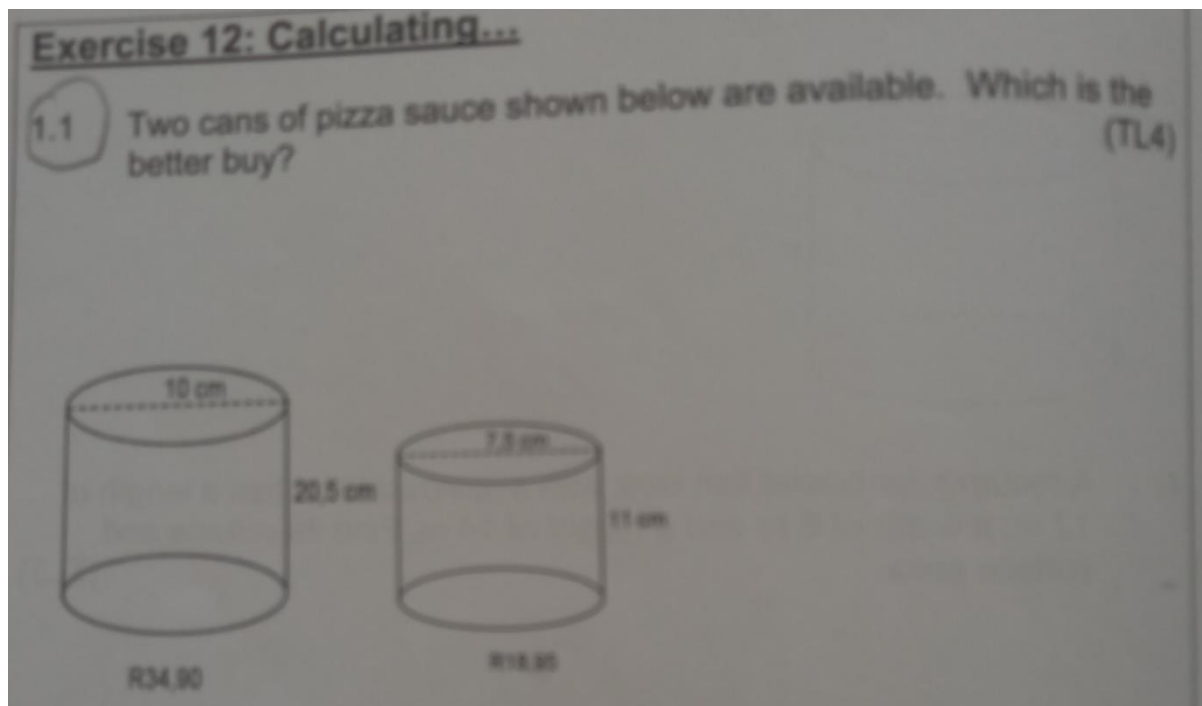
Learner: I did not know. [He indicated that he was possibly absent for that lesson].

Bridgette: Did I send the work on WhatsApp?

Learners: No.

Figure 9.6

Question from the textbook that was used in the observed lesson.



Bridgette: OK, actually, I did send a picture on WhatsApp because I sent it for you. [In the previous observed lesson the learner was absent, and the work was sent on WhatsApp for him and also to all the learners' parents in the observed class]. So please check on the WhatsApp for the revision work. If not, you can copy it from a friend. Have you all started revision for the exam?

Learners: Yes.

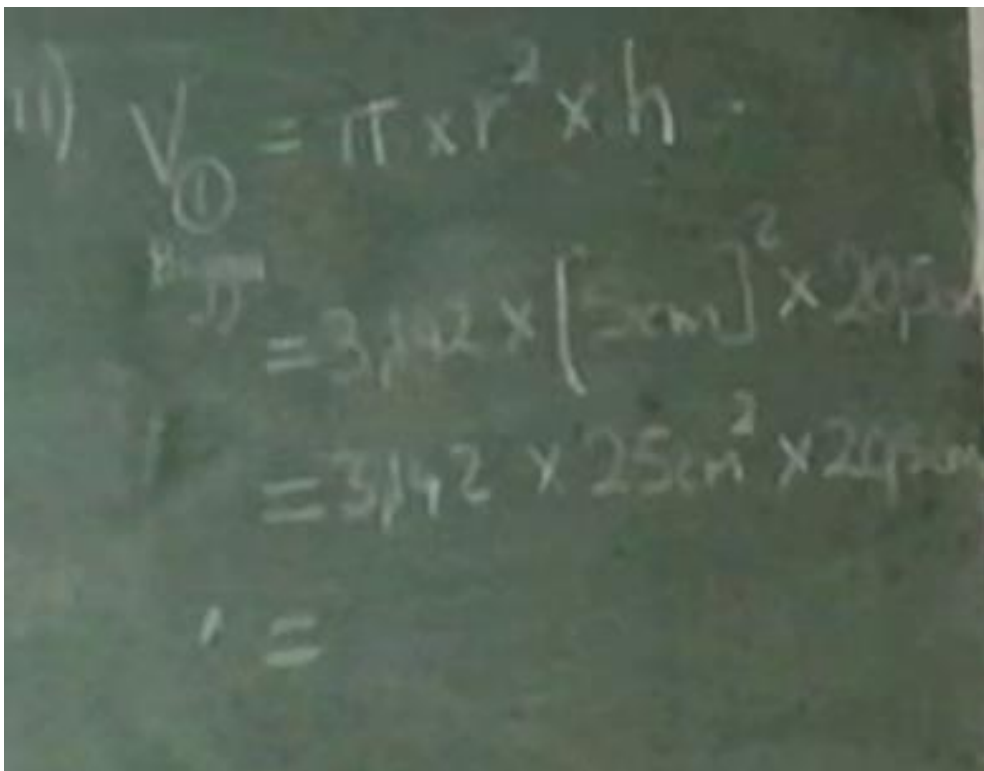
In the aforementioned extract is evidence of Bridgette's holding learners accountable for completing their homework and for examination revision. She uses available technology to involve parents and promote learning in and outside of the classroom.

Bridgette: What do we need to calculate here in order to determine which can is better for us [to buy]?

Learner: The volume.

Figure 9.7

Evidence of the method used by Bridgette to calculate the volume of a cylinder.



The image shows a chalkboard with handwritten mathematical work. At the top, the formula for the volume of a cylinder is written: $V = \pi \times r^2 \times h$. Below this, the calculation is performed using the value 3.142 for pi, a radius of 5 cm, and a height of 20.5 cm. The steps are as follows:

$$\begin{aligned} V &= 3.142 \times [5\text{cm}]^2 \times 20.5\text{cm} \\ &= 3.142 \times 25\text{cm}^2 \times 20.5\text{cm} \end{aligned}$$

The final result is partially visible at the bottom of the frame, showing $=$.

Bridgette: The volume, good. We are going to calculate the volume so we are going to calculate the volume of the bigger can and the volume of the smaller one. Who can remember the formula for [calculating] the volume of a cylinder?

Learner: The volume of a cylinder is $\pi \times radius^2 \times \text{height}$.

Bridgette: Good. So, the volume of the first cylinder is $\pi \times radius^2 \times \text{height}$, is that correct? [Bridgette writes the formula on the board].

Learners: Yes.

Bridgette: OK, so let's do the first cylinder, the bigger one. What is π , how much [is] π ?

Class: 3.142.

Bridgette: Times? How much is the radius? What would be our radius when our diameter is 10?

Class: 5 centimetres squared.

Bridgette: 5 centimetres squared. And what is our height?

Learner: 20.5 centimetres.

Bridgette: Who said 4? [Bridgette and the learners laugh].

Bridgette: Right, what is 5 cm squared?

Learners: 25cm

Bridgette: Good, so 5×5 is 25. So, you need 25 centimetres squared. [Bridgette is writing the calculations on the board] Can you see I am doing my work step by step? So now multiply that and tell me what you get? (See Figure 9.7.)

Learner: Miss, do we actually square the 25 in the calculator.

[A learner identified a mistake Bridgette made when she stated that the learners needed to square 25 instead of 5].

Bridgette: You are not going to square the 25 because it is centimetres squared. You are also going to square your exponent, remember when we did exponents? The laws of exponents, you have one exponent here [pointing to the number 5 that will be squared and pointing out the centimetres that will be squared too] of the centimetres squared, not the number.

In the aforementioned extract Bridgette places emphasis on procedural fluency by displaying the substitution of values into the formula for calculating the volume of a cylinder (see Figure 9.7).

Learner: Miss, the answer is 1610.275.

Bridgette: Can anyone else confirm that he has the right answer? [Learners are calculating the answer on their calculators].

Learners: Yes.

Bridgette: The answer is 1610.28. Remember to round [to] two decimal places.

Learner: The answer is 1610.28cm^3 .

Figure 9.8

Evidence of the method used by Bridgette to calculate the volume of two cylinders.

Handwritten calculations on a chalkboard showing the volume of two cylinders. The first cylinder's volume is calculated using the formula $V = \pi r^2 h$ with $r = 5\text{cm}$ and $h = 20.5\text{cm}$, resulting in 1610.28cm^3 . The second cylinder's volume is calculated using the same formula with $r = 3.75\text{cm}$ and $h = 11\text{cm}$, with the final result partially visible as $=$.

$$\begin{aligned} 11) \quad V_1 &= \pi \times r^2 \times h \\ &= 3.142 \times (5\text{cm})^2 \times 20.5\text{cm} \\ &= 3.142 \times 25\text{cm}^2 \times 20.5\text{cm} \\ &= 1610.28\text{cm}^3 \\ \\ V_2 &= \pi \times r^2 \times h \\ &= 3.142 \times (3.75\text{cm})^2 \times 11\text{cm} \\ &= 3.142 \times 14.0625\text{cm}^2 \times 11\text{cm} \\ &= \end{aligned}$$

Bridgette: Remember, the first law of exponents? When you multiply you add your exponents. You got the two and the one here and when you add them together you get the three [Bridgette is explaining the rules of exponents while pointing to the board to illustrate her explanation]. (See Figure 9.7.)

Bridgette: Alright. Now let us look at the volume of the second one, the smaller cylinder and again you are writing down the formula, $\pi \times r^2 \times \text{height}$. Then we substitute our values. What will be our radius this time [as Bridgette explains she writes the methodology on the board]? (See Figure 9.8.)

Learner: 3.75

Bridgette: 7.5 divided by two is 3.75.

Learners: [out loud with Bridgette] 3.75.

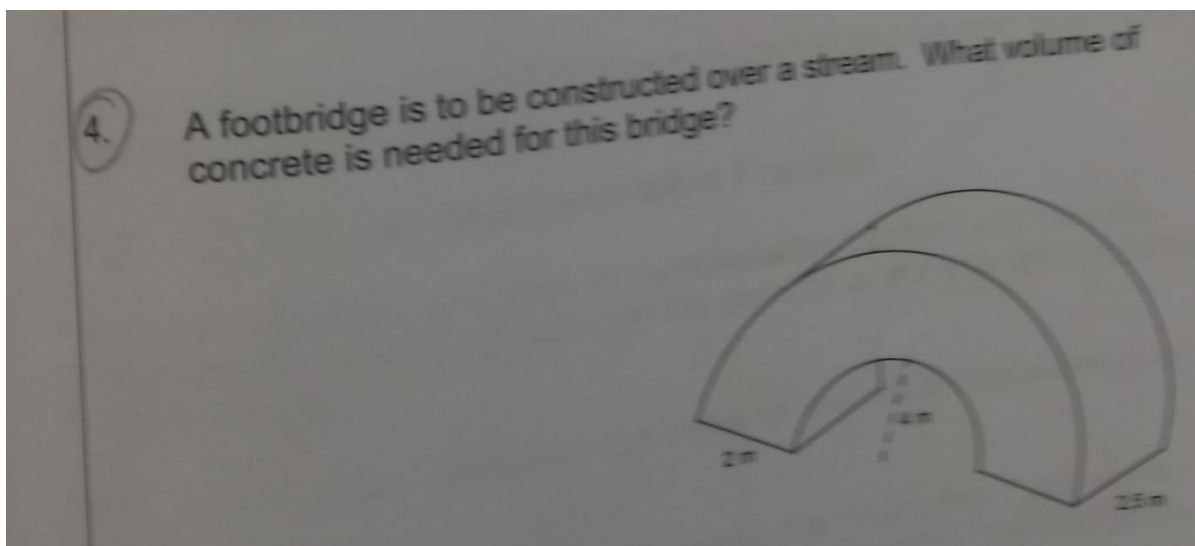
Bridgette: $3.75\text{cm}^2 \times \text{the height}$, which is what?

Learners: 11 centimetres.

Bridgette: 11 centimetres. What [is] 3.75cm^2 ? It is 14.06cm^2 . Good, and you bring down whatever you did not use (see Figure 9.8) and now you are going to multiply the entire thing.

Figure 9.9

Question from the textbook that was used in the observed lesson.



Learner: It's 486.03125 rounded off to two decimal places and the answer is 486.03.

Bridgette: Will we get the same thing correct in the exam?

Learners: Yes.

In the above extract Bridgette displays evidence of preparing learners for examinations by making them aware of the need to round off answers.

Bridgette: Alright, let's move on to 1.2. Is anyone taking down corrections (see Figure 9.8).

Learners: Yes.

Bridgette: OK I will give you guys a minute. I will take a picture of the corrections, too.

Unathi: Miss, which option is better between the two? Which is the best buy?

[Unathi identifies that the question was not completed since there needs to be a calculation as to which option is the better one].

Bridgette acknowledged that she had forgotten to return to this part of the question and indicated that the class will return to it another time.

Bridgette: Good, mathematics is also very logical thinking. If we have something we need to figure out, what we need to do to find it. How can we use what we do have to find out what we don't have? So, we now have the radius [so] is it possible now to calculate the area of the circle?

In the above extract Bridgette explains to her learners that it is important to view ML as needing logical thinking. She further explains that when one grasps the contextual setting using logical thinking, one can identify the mathematical demands and solve the question using the mathematical skills required.

Bridgette selected a learner to read the question out loud to the class.

Learner: A footbridge is to be constructed over a stream. What volume of concrete is needed for the bridge?

Bridgette: There is a footbridge that needs to be constructed over the stream and what will [be] the volume of the cement needed to build the bridge? Did you hear that we have a problem with one of the foot bridges here in Durban? It is actually news that came out yesterday. On the M4, between Umhloti and Umhlanga, there is a footbridge and its very shaky at the moment with some concrete already on the [ground] and on the road. I think it was the water damage, so that is news out of that.

OK, so how do we attempt this? So, what information have they given us to work with? Firstly, what shape is this bridge?

She established with the learners that the bridge is in the shape of a half cylinder according to the illustration.

Bridgette: First of all it is half a cylinder so the volume will be divided by 2. Then... if it is an entire cylinder what does it have in between it?

Learner: A space.

Bridgette: A space, there is a space inside the cylinder. That space needs to be calculated so it can be subtracted from the entire whole. Right! So, there are two volumes that we need to check. We are going to be checking the volume of the entire cylinder and [the volume] of the inner part and then we subtract... and remember whatever we do we are halving it because it is half cylinder. So, let's do that very quickly. What is the formula of the volume for a half a cylinder?

Learner: $\pi r^2 h$

Bridgette: Substitute the values and we will divide by two. So, for the first one the outer part is π times 3.142 times your radius. What is your radius?

Learners: 4 metres

Bridgette: We are looking at the outer part there, so it is 2m squared times the height. What is the height?

Learner: 4 metres

Bridgette: 2.5m, ok, what is 2m squared? 4 meters, so bring down what you have not used and multiply and what do you get?

Learner: 31.42

Bridgette: Can anyone confirm?

Learners: Yes.

Bridgette: So, it is 31.42 and what would be your unit of measure?

Learners: m^3

Bridgette: Now let's look at the volume of the inner part. OK, and using the same $\pi r^2 h$ divided by two, oh, did we not divide by two here guys?

Leaners: No.

Bridgette: Divide by two here and what do you get?

Learner: 15.71, Miss.

Bridgette: Who else is going to confirm with us?

Leaners: Same.

Bridgette: $15.71m^3$

Do the very same thing here. π is 3.142 times your radius. What is your radius?

Bridgette: Just one minute, radius is 4 m, times by same height, give me the final answer there, guys.

Learner: 125.68.

Bridgette: Good and divide by 2.

Learner: 62.84.

Bridgette: 62.84, m cubed, and what is the last thing we do boys and girls? Are you taking this down? Cole, what is the last thing we are going to do? We have got the volume of the outer part, we have got the volume of the inner part, and what are we going to do?

Learner: Add the two together.

Bridgette: No, we are taking out a piece, so . . .

Learner: We are going to subtract.

Bridgette: So, we are going to subtract, so we take the 62.84 minus 15.71 and what answer do you get?

Learner: 47.13

Bridgette: 47.13 meters.

Learner: Cubed.

In the above extract Bridgette refers to a contextual setting such as the flood that caused a considerable amount of damage to a bridge, and that fixing it required an understanding of how to calculate the volume of a half cylinder, thus linking a real-life event to the mathematical demands of the question given.

9.4 Views of Mathematical Literacy and the curriculum

Bridgette revealed in the questionnaire that she feels the difference between ML and mathematics is that they prepare learners for different career opportunities. Mathematics drives learners towards engineering and sciences and ML towards business. Bridgette also distinguishes differences between ML and mathematics in terms of content. She said, “The content of these two subjects differs drastically. Mathematics include algebra, trigonometry, geometry, algebra. ML include finance, maps and plans, measurements, data handling.” (See Figure 9.10.)

There were three threads that arose from Bridgette’s views of ML and the curriculum Likert scale questions obtained from her replies to the questionnaire (see Figure 9.10). The first thread was her disagreement with the pace of the curriculum. She indicated that she disagrees with the pace of the ML curriculum (along with four of the 32 respondents who agreed with her) but she agrees that the ML curriculum can be completed in an academic year (along with 12 of the 33 respondents who strongly agreed with her). Bridgette also agreed that learners should be taught the mathematical content before the real-life context is introduced (along with 12 of the 33 respondents who strongly agreed with her).

The second thread had to do with Bridgette’s mostly positive views of the curriculum content itself. She agrees with the relevance of the current topics in ML and with the necessity of these topics in ML (along with 13 of the 31 respondents who agreed with her), was neutral regarding the curriculum being well suited to achieve the purpose of ML (along with seven of the 33 respondents) and also neutral regarding the statement that the sequencing of the ML topics according to CAPS makes sense (along with eight of the 33 respondents). Bridgette was one of very few who agreed that ML needs more topics such as algebra and geometry (along with three of the 33 respondents who strongly agreed with her).

The third thread was Bridgette’s strong agreement about the importance of real life demands and expectations in ML. She agrees that ML learning supports learners dealing with real life problems (along with 11 of the 33 respondents) and that ML supports learners solve real life problems (along with 11 of the 33 respondents who strongly agreed with her) (see Figure 9.10).

Bridgette feels that the ML curriculum and questioning is context-based, so she asks her learners after the reading out the question, “What information have they given us already” to ascertain if they have grasped the context rather than the mathematical requirements of the question. Further to this, when learners were asked to calculate the volume of cement needed for a bridge (see Figure 9.9), Bridgette spoke about a bridge between Umhlanga and Umdloti that was eroding after the

floods in April 2022, in Kwazulu Natal. She indicated in the interview that she did this to link the question to something that had actually occurred.

Figure 9.10

Below is an extract from the completed questionnaire Bridgette submitted in relation to her opinions about ML.

Using the following scale of 1-5, use a number to indicate the degree to which you agree with the statements listed below, where

1	2	3	4	5
Strongly disagree	disagree	Neutral	agree	Strongly agree

- 2.3. I am pleased with the pace of the ML curriculum 1 ☒ 2 3 4 5
- 2.4. I am able to complete the curriculum each year 1 2 3 ☒ 4 5
- 2.5. All the topics in the ML curriculum is necessary 1 2 3 ☒ 4 5
- 2.6. The ML curriculum needs to include more topics, for example algebra & geometry 1 2 3 ☒ 4 5
- 2.7. The ML curriculum is well suited to achieve the purpose of ML 1 2 ☒ 3 4 5
- 2.8. The sequencing of the ML topics according to CAPS makes sense 1 2 ☒ 3 4 5
- 2.9. I believe that mathematics learning helps learners to deal with real-life problems 1 2 3 ☒ 4 5
- 2.10. I believe that ML is necessary because it will help learners solve real life problems 1 2 3 ☒ 4 5
- 2.11. In Mathematical Literacy, learners should first be taught mathematics content and then taught to deal with real life contexts 1 2 3 ☒ 4 5
- 2.12. A teacher needs a strong mathematical background for effective teaching of Mathematical Literacy 1 2 3 ☒ 4 5

Thus relating to the question, Bridgette said, “Our kids have to learn of the things that are happening in our daily lives because that is how they actually remember work as well.” Because of the contextual demand and the difficulty of this question, Bridgette said that it does feel that you need to teach learners more than just mathematics in a ML lesson. Bridgette indicated that she found the

question challenging, too, and that since questions can be vague and confusing, teachers can make mistakes too.

For the aforementioned reason, Bridgette voices her frustration with the experiences she has had with the DBE. She said that the DBE makes teaching and learning challenging when revision is to take place and in the actual examinations themselves. She indicated that the challenges for the learners present include the fact that there are several mistakes in the DBE ML examination papers, especially the common papers. Bridgette said, “We find a lot of errors in terms of the questions. When they set out the questions for the kids, in terms of the visual, they don’t put clear photos or maps for the kids and especially for [some of] our kids it is an extra struggle as they are visually impaired. We also find that the questions themselves are not properly set out, even, and we have many errors with the memos as well.” Bridgette indicated that this is especially challenging for learners who are second language English speakers. The challenges for the teachers have to do with memoranda that are changed several times so teachers create their own memoranda to determine learners’ results accurately.

Bridgette further indicated that learners struggle with the contextual demands of the ML curriculum. She used the example “In terms of reality, shapes they struggle with, in something 2D, so just bringing that relation from a 2D to a 3D, in reality makes it a bit difficult for them.” Bridgette indicated that the learners know how to calculate the area of the object, but, when the context complexities are added to the ML questions, the learners struggle to attempt questions successfully. Bridgette indicated that Covid-19 was another setback for learners in the observed classroom and so was the change of teachers in Grade 10 that led to learners missing a lot of opportunities in learning. Bridgette said, “They have a lot of gaps [in learning] so I am trying to build then from the gaps and also advance them in Grade 12 at the same time.”

9.5 English and its relationship with Mathematical Literacy

Even though Bridgette’s classes are small, the observed class had four different home languages. Bridgette said, “They are . . . hit with all these different languages, so it is a bit of a struggle.” Bridgette teaches using English only as the medium of instruction and feels that code switching can bring challenges for learners in understanding the complex wording used in assessments. She explained,

We can also get very easily used to the teachers translating into isiZulu and not having the ability to actually comprehend it in English for themselves. So, when I am teaching in

English, I try to go over the difficult words that are there and try to explain these words to them very literally so that they can pick up on the English vocabulary there.

I observed that learners are asked to read out questions in the class and Bridgette explained that the main objective for this is for them to “get practice in their English vocab and reading skills” and to keep them alert in the classroom. She also indicated that she changes the way she teaches in order to support learners when they struggle with complex mathematical language. Bridgette said,

Yes I do, like I try not to use the very difficult mathematical language for them. I test them and keep checking if they know what it is but when teaching I try [to] give them simpler words so they can actually concentrate more on the calculations than the vocabulary. It is also important for them to understand the mathematics and the language to use so we try to accommodate [this].

Bridgette further supports learners with ML terminology by giving them a mini glossary or definition examples. This is to support them in making a connection to the solution and the terminology that is connected to that solution. Further, Bridgette said, “Whenever I get a chance I try and test them on that as well.” She also confirmed that she feels that there is too much complex language in ML. She indicated that there is [often] a lot of information in one ML question. She said, “For a learner who [speaks] English as their first language, they can very quickly sift through, but for a learner [for whom] it is a second language and a learner who has visual impairment and a learner who is blind it is quite unnecessary for them to go through, and type [on a computer] and it takes up more of their time before they answer the question.”

Bridgette said that the only benefit for her learners is that they get an extra 15 minutes per hour extra in the Grade 12 final examinations to deal with issues such as the complex language used in the examinations. Bridgette indicated that she supports learners by using terms that she knows they understand.

When I asked her if she believes that her learners find ML difficult when they face the assessments/tests in written form in English. I asked if it was easier for them to hear the spoken questions. She replied that her learners find it easier to hear the questions since they struggle with reading them and that her learners can hear the tone in her voice that she uses to identify important aspects in the question. She said that her blind learners gain the greatest advantage of her reading the questions aloud since “their listening skills are much stronger than their reading skills.”

However, Bridgette does ask learners to read out numbers aloud from the calculator. She indicated that builds on their existing knowledge and that this is a problem in South Africa. For her, “They

will still struggle to read out numbers and understand them it and then you get something like how Zuma reads out numbers.”¹⁵

Bridgette was asked if she feels all learners, first and second language English speakers, struggle with the language used in ML and she replied that she believes all learners struggle with the language used in ML. She said,

It also depends on the child’s level of problem-solving skills, so although they [might] understand the language, their ability to solve problems and think logically could differ. It could be an advantage for them in terms of language in relation to understanding the language and comprehend[ing] it, but perhaps they are unsure about how to go about solving the problem and doing the calculations.

Bridgette indicated that second language and first language English speaking learners have different struggles. She has taught children with the ability to problem solve, who lacked English proficiency and thus struggled in ML.

9.6 Bridgette’s mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework

In this section I use the 4QCCDF as outlined in Chapter 3 to identify how Bridgette supported learners when they were working with ML tasks. During the lessons that were observed she used ML classroom tasks that were related to the instructions and contextual attributes that feature in the contextualised tasks exam paper.

The first task, Question 1, that was discussed during the lesson (see figure 9.2) is a complex multi-step question containing a simple contextual setting. The contextual setting was that of an athletics track and Figure 6.2 shows that it can be broken up into a rectangle and two semi-circles. For this task, learners were given the total distance around the track, with the length of the two straights of the track being 110 meters each. The learners needed to identify the dimensions of the two semi-circles and the rectangle. To do that, the straight-line distances of the athletics tracks had to be subtracted from the given distance around the track. They then needed to recognise that the remaining distance left of the athletics track formed the circumference of the two semi-circles and

¹⁵ The then president of South Africa, Jacob Zuma fumbled over his numbers in reading out 769 870 at an ANC conference on 11 October 2015.

this information could then be used to determine the radius of the two semi-circles that they were required to calculate.

The task can be placed in Quadrant B because the mathematical demand required multi-step calculations to solve the question. The question also required learners to make a connection between the information and the diagram in the question and required many steps as outlined in the process of solving it. Since the diagram was set in the context of an athletics track the contextual language and setting of an athletics track and of an inside lane needed to be interpreted and understood.

Bridgette supported the learners by saying, “OK, what is this question asking of us, boys and girls?” She extracted the mathematical demand in a step-by-step manner. She indicated to learners that 220 meters had to be deducted from the 400 meters without explaining the contextual setting from which this information was extracted, thus simplifying the question further for the learners. After determining the mathematical demand of the task, Bridgette then asked learners questions to determine their understanding of their ability to complete the task. Bridgette asked, “OK, so how do we go about answering this question? What do we find first?” Bridgette completed the question on the board in a step-by-step manner while encouraging the learners to give input to attain the correct answer (see Figure 9.3). Bridgette asked learners several times during the process of solving the question if they understood what she was explaining to them in order to ascertain how much support she needed to give them in this step-by-step way. Bridgette thus moved from Quadrant B to Quadrant D by extracting the contextual setting and then moved into Quadrant C as she supported the learners in completing the mathematical demands of the question by breaking it down into single step simple calculations.

For Question 3 (see Figure 9.5) there is no contextual setting, but this is a multi-step question. The question required learners to calculate the volume and surface area of a cube, so this question falls into the categorisation of Quadrant D. In this task, Bridgette still questioned the learners to see if they could identify the mathematical demand of the task.

Bridgette: What does this mean, learners? Anyone? Luyanda?

Luyanda: To calculate the surface area of the object.

Bridgette: The surface area. Good. And what else are we finding?

Luyanda: The volume.

Bridgette broke the calculations down into a step-by-step process in an attempt to move from Quadrant D to Quadrant C when she gave the formula for volume and surface area to the learners

after they had identified the mathematical demands of the task. Bridgette broke the calculations down into easily manageable ones when she made the learners substitute the information she supplied to them for the formulas and then turned the questions into simplified one-step calculations.

The following question, Question 1.1 (see Figure 9.6) is categorised as a Quadrant D question because it is a multi-step complex one with a simple contextual setting of the need to determine a best purchase situation using the volume of two cylindrical tins of pizza sauce. The question consisted of a diagram of two cylinders (tins of pizza sauce) of which the dimensions were given. The volume had to be calculated and, since each cylinder was given a selling price, the best buy had to be determined. During the lesson observation, Bridgette questioned the learners to check if they understood the concept of the volume of a cylinder. She supported the learners in identifying the mathematical demand and then by providing the learners with the required formula to calculate the volume of the two cans. Bridgette moved from Quadrant D to Quadrant C by removing the multi-step demands in the question and breaking down the calculations into simplified one step calculations (see Figure 9.7) in order to determine which tin was the best value for money.

Question 4 (see Figure 9.9) is placed in Quadrant D because it is a complex multi-step question with no contextual setting. The question involves a bridge and the volume of concrete required to build it. Learners needed to understand that the bridge consisted of two half cylinders so the volume of these had to be calculated. The larger half cylinder's volume was to be subtracted from the smaller one in order to calculate the volume and amount of cement needed to build the bridge. After reading the question, Bridgette used a real-life example to support learners in gaining an understanding of the need to maintain and build bridges. Bridgette referred to a local footbridge having been damaged in a recent storm. Bridgette moved briefly from Quadrant D to Quadrant A by placing the question into a real-life setting. She then supported the learners by removing the multi-step demands of the question, including supplying the learners with the formula required to determine the solution of the question. She then further supported the learners by substituting the required information for the formula and breaking down the calculations into simplified one step calculations. Thus, Bridgette moved from Quadrant D to Quadrant C.

9.7 Conclusion

In this chapter I presented my findings on Bridgette the kind one, that I collated from the data collected in the questionnaire, my observation of her lesson, and my interview with her. I discussed her background and teaching environment to explain the teaching conditions and environment with

which she is faced. I present the transcript of the lesson observed for insight into Bridgette's teaching methods. Following this I explored her views on ML along with what she thinks of the relationship of this subject to English proficiency. In looking at Bridgette's view of the reading, writing, and English skills of her learners I was able to determine her perspective on, and approach to, this study's research questions. Bridgette was observed using the 4QCCDF and it was noted that she continually supported learners in extracting the mathematical demands from the contextual settings and in breaking down multi-step questioning into single-step calculations. She worked continually from Quadrants D, A, and B and kept moving to Quadrant C to support learners to arrive effectively at the solution of the questions presented in the classroom. On a rare occasion, Bridgette was observed moving from Quadrant D to Quadrant A to give learners a real-life example of the question and thus showing them how the question could be presented with a contextual setting. Even though the questions Bridgette gave the learners in class could be categorised into different Quadrants of the 4QCCDF, she continually moved to Quadrant C to support learners in the extraction of the contextual setting and by simplifying the mathematical demands into one-step calculations.

Chapter 10: The Organiser

10.1 Introduction

In this chapter, I present my findings relating to the participant I have chosen to call Njabulo the organiser. I include the findings from his questionnaire, my observation of his lesson, and the interview I held with him. The purpose of this chapter is to present how Njabulo interprets ML and his views on the challenges of teaching ML. I conclude with my findings in relation to how he feels about the relationship of English to ML. The aim of this analysis is to determine whether Njabulo believes that there are language demands associated with the learning of ML.

10.2 Background of the participant and his teaching environment

Njabulo is a proficient teacher in his mid-thirties and a supportive Head of Mathematics at a school that is located in a township northwest of Durban city. Nothando, another participant in this research study (see Chapter 7) is a teacher in his department. Njabulo has a prolific educational history in comparison with his fellow colleagues and presented interesting viewpoints that were opposed to those of other participants. Njabulo gained experience at a prestigious private school in the Midlands of Kwazulu Natal where, as he explained, “We started using technology and I was introduced to different types of software like Autograph, Geobra, and Sketchpad, so I am familiar with these kinds of technologies.” This exposure to technology has provided Njabulo with a unique view on teaching mathematics given how few teachers in South Africa have had similar exposure. Njabulo is trained in teaching mathematics and has been doing so for the last thirteen years along with teaching ML for the last two.

I noted in Njabulo’s lesson observation that he is a very calm and effective teacher, and it was evident that he had gained the respect of the learners since they were very well mannered and produced work of high quality for him. Njabulo said that he has been working at this school for ten years and has acclimatised himself to the environment in which he works. He indicated that the school is community-based and not well-resourced. As mentioned above (see Chapter 7), the school is a quintile 3 resourced school with minimal resources. The classroom environment is very challenging since there are no doors, few windows that still have glass in them, and no electricity in the classrooms. The walls separating the classrooms were built to the height of the ceiling board, but this was never added so the noise from neighbouring classes disrupts teaching and learning for all in the classrooms (see Figure 7.1 and 7.2). The school was the least resourced school in which I

conducted observations. Njabulo indicated that his challenges in teaching are resource-based as mentioned before, and he also said,

We need to move with the times, we need [to] be working with technology [but] we don't have access to all those things. . . There are no textbooks [so] learners are now using cell phones since they need to do things that are of the 21st century.

Regarding this challenge, Njabulo feels that, for him, it is all about adapting. He said, "Getting used to teaching a large number of learners, you need to keep on improving [and] now and again [you have] 60 to 70 learners [so] you . . . take care of [it]."

Figure 10.1

An extract from the completed questionnaire Njabulo submitted in relation to his thoughts about his own English proficiency.

3.2. I am very proficient in speaking English	1	2	3	4	5
Comment					
In a scale of 0% to 100% I can say					
I am at 60% proficient in speaking English					

Njabulo was observed teaching a Grade 10 ML lesson. The class consisted of over 50 learners. He displayed very efficient classroom management skills in the classroom.

Njabulo is an isiZulu home language speaker, but, as I found in my interview with him, he is more proficient in English than he claimed to be in the questionnaire (see Figure 10.1). He told me that most of the learners in his classes are isiZulu speakers but added, "I might not be 100% correct; a learner might come from Eastern Cape." This was a reference to some learners being isiXhosa speakers.

10.3 The lesson transcript

I observed Njabulo for two Grade 10 ML lessons and the class consisted of over 40 isiZulu-speaking learners. Njabulo was reasonably confident that all the learners in the observed lessons were isiZulu speaking learners although, as mentioned in the aforementioned, there might have been an isiXhosa speaker as well. Njabulo addressed the complexities of teaching learners who do not speak English as a first language by using code switching to help them understand the challenges presented in ML.

I observed certain distinct patterns in Njabulo's use of language; he used isiZulu as the medium of instruction for general discussion in the lessons and also to speak individually to learners in the classroom. He also read the questions out loud in English several times and code switched by adding a sentence in isiZulu to make the contextual setting and the mathematical demand more evident to the learners. He wrote on the board only in English even when he explained to the learners in isiZulu.

Njabulo printed out past examination paper questions and he handed them out to the learners to complete during the observed lessons. He explained the key concepts effectively by incorporating them into the lessons rather than introducing the concepts only at the beginning of the lessons. For long periods of time I observed Njabulo supporting learners as they were completing the tasks allocated to them. Below are extracts taken from the two lessons observed.

10.3.1 Lesson observation

a) The first observed lesson

The learners came into the classroom, collected the worksheet for the day, and settled in. Njabulo wrote the key words on the board while learners were getting their books out.

Njabulo¹⁶: *You need to organise the data, organise*¹⁷ data collection. *What do we do in Data Collection?* It is an organiser [in which we] collect, organise, summarise. We represent or display data. [Together, the learners repeat with Njabulo, represent or display data]. Discussing today's objective, data can be displayed in a histogram, in bar graphs or in pie charts. *Sezwa?*¹⁸

¹⁶ These transcripts have been lightly edited in the interests of economy and coherence.

¹⁷ The isiZulu translation is in Italics. It is important to identify Njabulo's emphases when he is using code switching.

¹⁸ This translates to "we heard" and also means "Are you following?"

Learners: Yes.

Njabulo: So, when we have data that we want to represent [we use] bar graphs, histograms, or pie charts. *We heard?*

Learners: Yes.

Njabulo: Say, for example, I have a bar graph [draws the axis of a bar graph] showing the percentage of pupils' passes in each grade. So, the bars will be Grade 8, Grade 9, Grade 10, Grade 11, and Grade 12 [as Njabulo says each grade he writes the details on the x-axis of the bar graph] (see Figure 10.2). So, what I will show you here is an example, [I am show[ing] you past percentages . . . for one year. This is for 2021 [he writes 2021 to indicate the title of the bar graph]. *This is where you label the percentages* [Njabulo labels and writes on the y-axis of the bar graph 10%, 20% . . . 100%. As he writes the percentages on the axis, he says the percentage out loud]. *We heard?*

Learners: Yes.

Figure 10.2

Displays the initial steps taken in drawing a bar graph showing the percentage of pupils passing mathematics in each grade from 8 to 12 in 2021.



Njabulo: So, this side shows the percentages. Right, now, let's say, for an example, Grade 8s obtained a 40% pass last year. So, if I draw the bar it will look like this [pointing to the graph], so that is for my Grade 8s. *We agree?*

Learners: Yes.

He draws a bar for Grade 8 up to 40%. (See Figure 10.2.)

Njabulo: Then let's say [for] Grade 9, we give them a percentage, for example, [of] 70%. He draws a bar for Grade 9 up to 70% on the board.

Njabulo: Grade 9, 70% like this. What is important is that our bars must be [of] equal size. Bars must be [an] equal distance apart. *It is important the bars must be bigger than or smaller than . . .* [as he speaks in isiZulu, he points to the board to support his statement]. *We heard?*

Learners: Yes.

Njabulo: Grade 10, 80% [he says this out loud as he draws the bar on the board]. *Is that correct?*

Learners: Yes.

Figure 10.3

Displays the complete drawing of a bar graph showing the percentage of pupils passing mathematics in each grade for 2021.



Njabulo: [draws the Grade 11 bar on the board]. Grade 11, 50%. That is my Grade 11 [bar] and my Grade 12 [bar]? Let us say 100%. [he draws the bar on the board]. (See Figure 10.3.)

At the start of the class Njabulo introduced the key word for the lesson, Data Collection. Njabulo uses English to introduce the concept to the learners and then furthers his explanation by telling the learners what a bar graph is. Njabulo also places emphasis on the identification of the mathematical demand and on how to draw a bar graph accurately. Njabulo repeated important components of the mathematical demand in isiZulu to the learners to ensure that they comprehended this.

Njabulo: I want to compare 2021 and 2022 using our bar graphs again. *We heard?*

Learners: Yes.

Njabulo: *I want to compare the 2021 and 2022 using the graphs.* [Njabulo writes the title of the new graph as 2021 and 2022 and learners say 2021 and 2022 with Njabulo]. *We heard?*

Learners: Yes.

Njabulo: The same thing [Njabulo draws the axis for the bar graph] to Grade 8, Grade 9, Grade 10, Grade 11, and Grade 12. [As Njabulo says each grade he writes out the grade on the x-axis of the bar graph]. (See Figure 10.4.) *We heard?*

Class: Yes.

[Njabulo labels y-axis of the bar graph with 10%, 20%, 30% ... 100%, as he writes the percentages on the axis Njabulo speaks the percentage out loud]. Do you notice the spaces are all equal? [He refers to the percentages on the y-axis labelling of the graph]. (See Figure 10.4.)

Learners: Yes

Njabulo: The scale is important, so I am counting in scales of 10, 20%, so they are equal.

Learners: Yes

In the above extract Njabulo places emphasis on reiteration since he is determined that the learners recognize the importance of being able to draw a bar graph accurately. He added that learners need to focus on the spacing of the bars since they need to be equally distanced from each other.

Njabulo: I note in 2021, 50% [points to the Grade 8 bar graph for 2021]. (See Figure 10.4.)

Learners: 40% [they correct Njabulo who read the information from the graph incorrectly].

Njabulo: [draws a bar of 40% on the 2021 and 2022 bar graph]. That is 2021. Let us say they improve this year and obtain 60% [draws a bar joining the 2021 bar up to 60% for Grade 8s' pass percentage]. On this side I have my [he draws stripes on the 2021 bar of 40%]. . .?

Figure 10.4

Displays the completed drawing of a single bar graph showing the percentage of pupils passing mathematics in each grade for 2021 next to an initial drawing of a double bar graph showing the percentage of pupils passing mathematics in each grade for 2021 and 2022.



Learners: 2021.

Learners: Yes.

Njabulo: 2021. You see? [shades the 2022 bar up to 60%]. I note in 2021 they obtained 40% [learners say 40% together with Njabulo]. 2022, 60%, so I am using that shading to differentiate between 2021 and 2022 [learners say 2021 and 2022 with Njabulo]. So, I am making a comparative bit here [pointing to 2021 bar graph] it was just 2021. We do the same thing to Grade 9. Grade 9 was 70% [draws a bar for the Grade 9s' percentage pass for 2021 on the double bar graph up to 70% and draws stripes in the bar to differentiate it from the 2021 bar in the bar graph]. It was 2021. And then we say they improve to let's say 80%. [He draws and shades the 2022 bar up to 80% for Grade 9.] You see? (See Figure 10.4.)

Learners: Yes.

Njabulo: So, you are going to do the same thing for Grade 10, 11, and 12. So this one is a simple bar graph and this graph that we've drawn is a double bar. Repeat with me [learners repeat double bar with Njabulo]. I'm drawing the information for 2021 and 2022. *We heard?*

Learners: Yes.

In the above extract Njabulo scaffolds onto the familiar scenario by comparing two years of examination results as presented in a bar graph. He does so in a step-by-step process in having the

Figure 10.5

Displays the complete drawing of a bar graph of Farmer Frank's total sales of vegetables for day 1.



learners guide him through the process to display their understanding and ability to draw a single or double bar graph themselves.

Njabulo: [Moves to new question] Farmer Frank takes his produce to the farmers' market every weekend. Below is the three-day record of the vegetables that were sold in pounds. *Did you understand?*

Learners: Yes.

Njabulo: Use this table to draw a multiple bar graph. They say it is a multiple bar graph but this is how I [want] us to draw and sketch it. We start by drawing a single bar graph, then double bar graph, and last we draw a multiple *We heard?*

Learners: Yes.

Njabulo: *You draw a double bar graph and when there are three of the above pieces of information you draw the multiple bar graph.*

Learners: Yes.

Njabulo: Now I want us to look at the table down there. [Reads this information from the worksheet] There is day 1, day 2 and day 3, you see that?

Learners: Yes

Njabulo: *There is vegetables, squash, zucchini, kale, carrots, lettuce, and tomato, right. The different vegetables are displayed and there are different days. So now I want us to draw a bar graph of day 1. (See Figure 10.5.) They count the vegetables that are on sale. Someone wants to buy the vegetable, like carrots for example. We heard?*

Learners: Yes.

Njabulo: Take out your exercise books. *We can draw the axis together* so we start by drawing day one. *Start at day 1, then do day 1 and day 2 together, then do day 1, 2, and 3 together. We heard?*

Learners: Yes.

In the above extract Njabulo elaborates on the question given. For each sentence that he reads of the question, he adds a sentence in isiZulu to familiarise the learners with the contextual setting. It is significant that Njabulo explains familiar contexts such as examination results in English and further elaborates in isiZulu on unknown contextual settings. Thus, he acclimatised the learners to drawing single and double bar graphs and then introduced a foreign contextual setting of the sales of vegetables in a market.

Njabulo: *Manthlo, come, let us start with day 1, squash in the form of a bar.* [A learner comes up to the board and draws the bar for squash for day 1 on the bar graph]. *We are going to draw the diagram for squash. Squash is 30.*

Learners: Two.

Njabulo: So, 32. *Write this in your own exercise books. We heard?*

Learners: Yes.

Njabulo: [The learner finished drawing the bar for squash for day 1.] *Was it drawn accurately?*

Learners: Yes.

Njabulo: Good. *Let us look again, so we are only doing day 1.*

Learners: Yes.

Njabulo: *So, the next one is 40 pounds.* [A learner raises her hand and Njabulo gives her the chalk to draw the bar for 40 pounds of zucchini]. *Can you draw the bar on the board? Is that 40 pounds drawn correctly?*

Learners: Yes

Njabulo: Can you help us with kale? [The same learner draws the bar for kale at 56 pounds]. *Kale is?*

Learners: 56.

Njabulo: *Does that look correct?*

Learners: Yes

Njabulo: *Everybody must do it themselves.* [The same learner draws the next bar which is carrots for day 1]. Good [Njabulo cleans the board]. Carrots is at 28, lettuce is 27, and tomato is 44. [The learner quickly draws the bars for lettuce, tomato, and carrots on the bar graph]. *Let us say thank you.*

The learners clap their hands for the learner you completed the bar graph. They then copy the bar graph of day 1 into their books.

Njabulo: *We are lenient with the accuracy of the bars if they are completed on the board, but when you complete them in your exercise book, they will need to be accurate. Now, this is important, this graph, compare the 2021 and 2022. We heard?*

Learners: Yes.

Njabulo: *The bars must be higher and lower.*

In the above extract it is clear that Njabulo uses the learners to complete work on the board in order to give him time to support individual learners in the classroom. It is significant that all

conversations with learners individually and in groups are conducted in isiZulu since Njabulo attempts to support learners in a language that he feels is best suited to their needs.

Njabulo: *We are now moving together to a double bar graph.* (See Figure 10.6.) Draw your bar graph. [He walks among learners and checks that they are completing the double bar graph correctly.]

Njabulo now draws up a bar graph and labels the y-axis with pounds scaling on the board and labels it Day 1 and Day 2. He continues to look at learners' work to see if they are copying the graph correctly. While learners are working on drawing the bars for day 1 and day 2, Njabulo asks a learner who has completed the double bar graph to complete it on the board. The learner uses her book to copy the correct drawings of the double bar graph on the board. Njabulo speaks in isiZulu to a group of learners about displaying a key to distinguish between day 1 and day 2 of the double bar graph.

Njabulo attends to individuals' needs in their own language and has learners show the answers so that he can focus on supporting others who need help.

Figure 10.6

Displays the initial drawing of a double bar graph showing Farmer Frank's total sales of vegetables for day 1 and day 2.

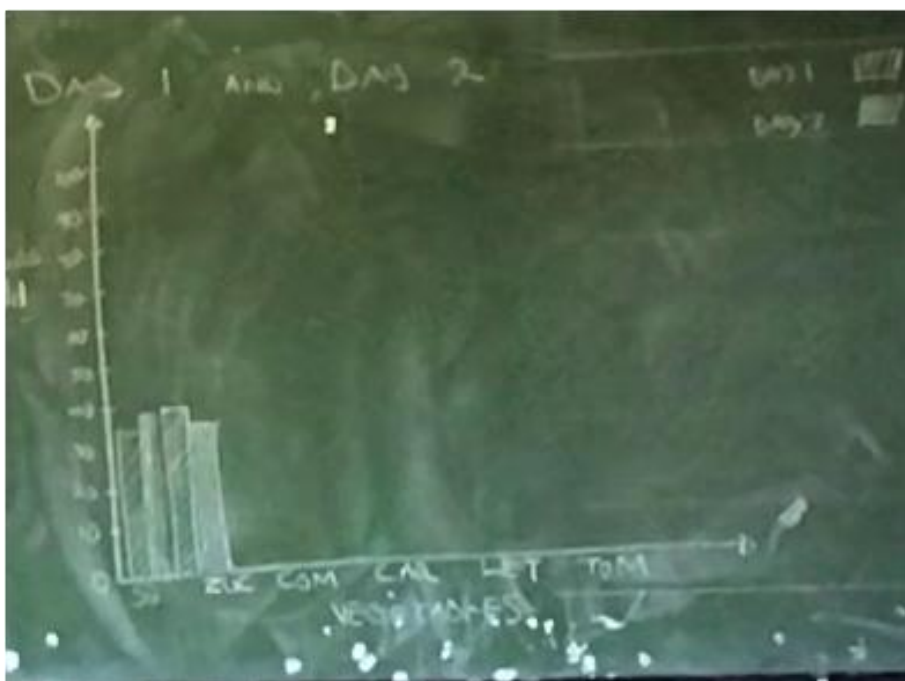
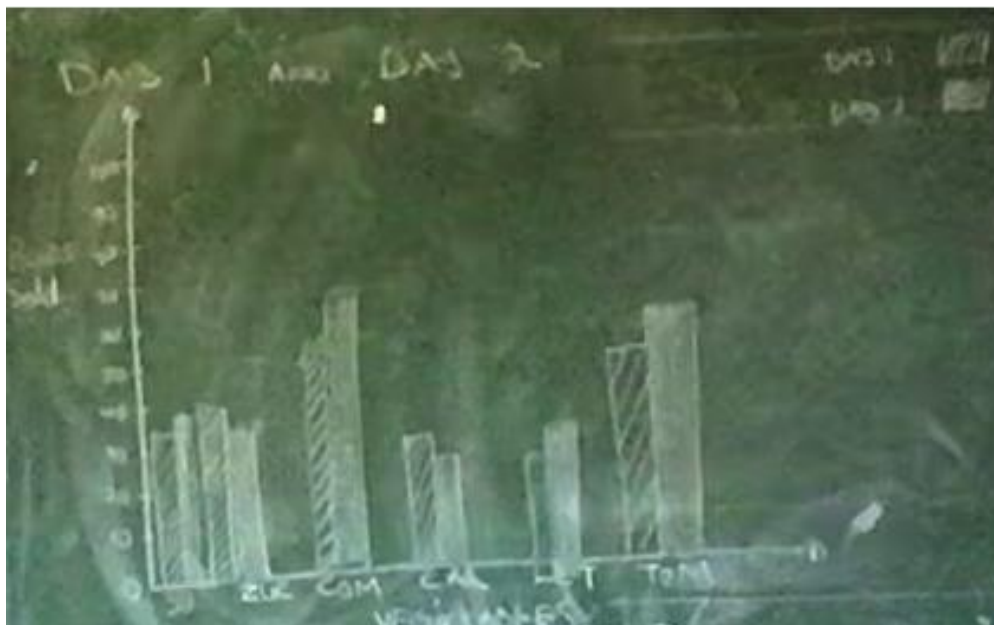


Figure 10.7

Displays the complete drawing of a double bar graph showing Farmer Frank's total sales of vegetables for day 1 and day 2.



Njabulo: *Can I have your attention quickly.* Let us just look at the board. Can you see this one is a presentation [pointing to the worksheet]? It is in a table form, and here [pointing to the bar graph] this is a presentation [put] graphically [as] a bar graph but can you see how they speak to each other?

Learners: Yes.

Njabulo: What do I mean if I say they speak to each other? This bar is a 32 and this bar is a 40, so this bar is bigger than that one. *When you do this graph, compare the years, this makes sense, right?* (See Figure 10.7.)

Learners: Yes

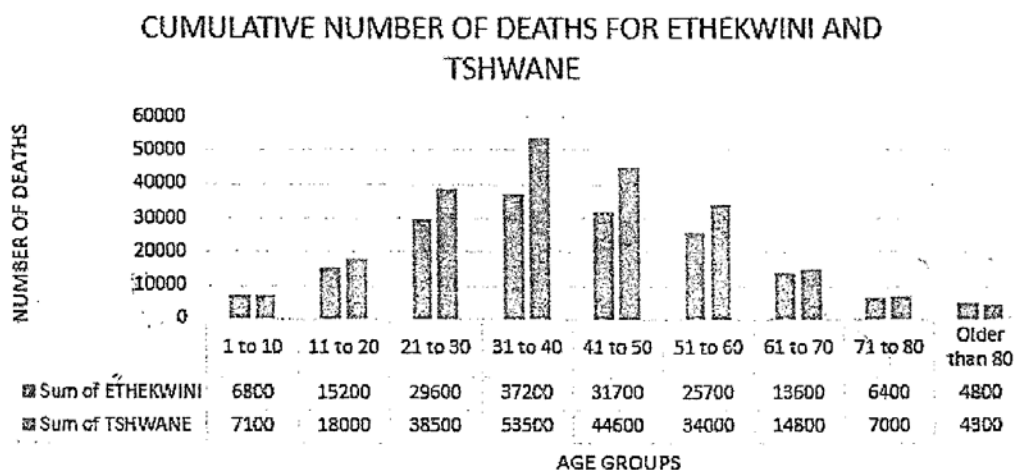
In the above extract we see that Njabulo supported learners individually but if he felt that there was a misconception that needed to be addressed, he gained the attention of all the learners in the class and addressed it right away. Following is an example of a learner struggling to understand the meaning of the relationship between the table given in Question 3 and the presentation of this data on a bar graph. So Njabulo places emphasis on the relationship by explaining that the data on the table speaks to the data on the bar graph.

Njabulo: Let us do 3.3 now. *We heard?*

Figure 10.8

Reflects a question used in the observed lesson.

- 3.3. Nishen lost a close friend who lived in Tshwane during the second wave of Covid 19. He drew up the graph below to compare the cumulative number of deaths per age group in both districts.



- 3.3.1 Which age group has the third highest number of deaths?

(2)

Learners: Yes.

Njabulo: *You must understand the graph before you get to the mathematics. We heard?*

Learners: Yes.

Njabulo: There are two key points in the question, eThekweni and Tshwane (see Figure 10.9). We understand something before we answer the question. What else do we notice before we go to the question? Some [is] of eThekweni, some of Tshwane. So, we are comparing two districts. There is Tshwane and there is eThekweni. *Let's go.* So, just be sure, the first one is eThekweni and the second one is Tshwane, *Is it?*

Learners: Yes.

Njabulo: *The line we are working with is the vertical.* Now the number of deaths. *This will be vertical, so the number of deaths. . . it is?*

Learners: Yes.

Njabulo: *And the horizontal?*

Figure 10.9

Displays the data required for question 3.3.

TABLE 1: RECORDS OF NEW CASES AND NUMBER OF DEATHS

	SOUTH AFRICA		KWA-ZULU NATAL		ETHEKWINI	
DATE	NEW CASES	DAILY DEATHS	NEW CASES	DAILY DEATHS	NEW CASES	DAILY DEATHS
10-Aug	6590	189	1525	3	526	1
11-Aug	7502	573	1979	68	641	21
12-Aug	14271	473	3603	76	984	30
13-Aug	13921	384	3359	160	1788	15
14-Aug	13021	238	3445	64	1572	24
15-Aug	10139	272	2878	98	1713	49
16-Aug	7983	299	1949	87	1183	42
17-Aug	10685	553	2288	92	665	38
18-Aug	14728	384	3750	54	1007	16
19-Aug	13672	317	3911	38	1717	14
20-Aug	14312	281	4198	89	1846	28
21-Aug	13261	268	3884	88	2100	23
22-Aug	10748	170	3369	48	1675	18
23-Aug	7632	163	2542	42	1128	20

Learners: Age.

Njabulo: Number of deaths vertically, horizontally, age? So, it is important to label your axis [labels the y-axis of a graph by writing number of deaths to illustrate]. Let us slot these numbers in. So, it is important to label your axis, otherwise your graph doesn't make sense. *You label your horizontal axis, age.* [Labels the x-axis, age, to illustrate the labelling of the graph]. *This gives you two marks. We heard?*

Learners: Yes.

Njabulo illustrates this by displaying two ticks next to the labelled axis. He explains that you start by labelling the axes because otherwise you cannot plot information.

Njabulo: [in mixed English and isiZulu] I look at the age, horizontal, look at the deaths, vertical.

In the aforementioned extract Njabulo explains that we must understand before we answer the question. He emphasises the need to understand the contextual setting before he looks at the mathematical demands of the question. He entices learners to tell him what information they think they must understand before they can answer the questions given. In other words, he wants them to give him the key words in the contextual setting that need to be understood.

Njabulo: 3.3.1. Which age group has the third highest number of deaths?

Learners: 31–40.

Njabulo: 3.3.1. Which age group has the third highest?

Learners are hesitant to answer since they are not confident about answering the question.

Njabulo: OK, let us understand the question first. *You start with the highest, then second and then finally the third.* Let us start at the highest, so we will see what is the highest.

Class: 31–40.

Njabulo: That is the highest.

Learners: Yes.

Njabulo: Second highest?

Learners: 21–30.

Njabulo: The second highest?

Learners: 21–30.

Njabulo: 21 to?

Learners: 30.

Njabulo: Yes, I agree, the problem is to first understand the question. *We heard?*

Learners: Yes.

In the aforementioned extract Njabulo places emphasis on how the learners read and understand the question and elaborates on this in isiZulu to make the learners understand the signifier, i.e., the third highest value.

Njabulo: Determine the difference between the median, underline the word median, the word median. If you don't know what the word median is, it not going to be possible for you to answer the question. Am I correct?

Learners: Yes.

Njabulo: What does the word median mean?

Learners discuss it among themselves.

Njabulo: [It means] at the center. So, determine the difference between the median of eThekweni number of deaths and the median of Tshwane number of deaths. So, if they say difference, we are subtracting here. What are we subtracting here?

Learners: Median.

Njabulo: Yes, the median.

Learners: Yes.

In the above extract Njabulo identifies that learners are struggling to answer the question because they do not understand the term median, so emphasises this and elaborates on the meaning of this term.

Njabulo: So how did you identify the median if you didn't put your numbers in order? [Njabulo writes the nine provinces' numbers of deaths as recorded in the table of Question 3.3. Njabulo writes the numbers on the board and the learners say the numbers out loud as he writes them on the board] (see Figure 10.9 and Figure 10.11).

Njabulo: *So, you look at the numbers, 1, 2, 3, 4* [points to the first four numbers he had written down and then points from the last number written down to find the middle number and circles it]. (See Figure 10.10.)

The numbers are not displayed in ascending order.

Njabulo: Is it correct to say this is the median?

Learners: No.

Njabulo: Is it correct? Why?

The class discusses this matter with Njabulo. He points to a learner and listens to her answer. He repeats her answer.

Njabulo: Because you [must] put your numbers in ascending order first. So, it is wrong to say this is the median for the first numbers. *We heard?*

Learners: Yes.

Njabulo: You need to understand the median, the word 'median' and how do you go about getting it and the word 'difference.' Other than that, you won't be able to answer the question. *We heard?*

Learners: Yes

Njabulo: So, you start. Let us put the numbers in ascending order [he writes the nine provinces' numbers of deaths in ascending order on the board and the learners say the numbers out loud as he writes them on the board]. (See Figure 10.10.) To be on the safe side, count them, the information, 1, 2, 3 . . . 9, so there are no numbers left out. Then after that you find the median. Where is the median? 15200 [Njabulo counts up to the fifth value in the data set and circles it]. (See Figure 10.10.) *We heard?*

Learners: Yes.

Figure 10.10

Displays median calculations on the board

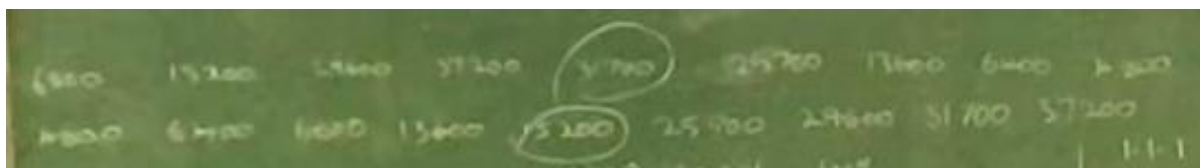


Figure 10.11

Reflects a question used in the observed lesson,

- 3.3.4 Determine the difference between the median of eThekweni number of deaths and median for Tshwane number of deaths.

(6)

Njabulo: That was for the first group, eThekweni. You do the same for Thwsane, after that you find the difference. *We heard?*

Learners: Yes.

In the aforementioned extract Njabulo identified the key word that the learners struggled to comprehend. He then furthered his explanations with methodological correctness by having learners understand that to determine the median of a set of numbers, the numbers need to be placed in ascending order. He extracted this information from the learners and made them correct him in finding the solution to the problem.

10.4 Views of Mathematical Literacy and the curriculum

Njabulo views ML as “more of [an] application of real life activities while mathematics is pure. ML is for helping with decision making in life while mathematics is for academic purposes if you want to study further.” Njabulo stated that he feels that the mathematics curriculum in Grade 8 and 9 is a preoperational precursor for learners to succeed in ML at FET phase. There were three threads that arose from Njabulo’s views of ML and the curriculum Likert scale questions he answered in the questionnaire (see Figure 10.12). The first thread was his agreement with the pace of the curriculum (another five of the 32 respondents agreed with him) and that the ML curriculum can be completed in an academic year (another 12 of the 33 respondents agreed with him). He also agreed that the learners should be taught the mathematical content before the real-life context is introduced (another 12 of the 33 respondents agreed with him).

The second thread concerned Njabulo’s neutral stance on the curriculum and its content. He displayed neutrality with the current topics in the ML curriculum, was neutral about the necessity of the topics of ML (along with four of the 31 respondents), was neutral regarding the curriculum being well suited to achieve the purpose of ML (another seven of the 33 respondents agreed with him), and again displayed neutrality with the sequencing of the ML topics according to CAPS (another eight of the 33 respondents agreed with him). Njabulo strongly disagreed that ML needs more topics such as algebra and geometry (another 14 of the 33 respondents strongly disagreed with this).

Figure 10.12

Below is an extract from the completed questionnaire Njabulo submitted in relation to his opinions about ML.

Using the following scale of 1-5, use a number to indicate the degree to which you agree with the statements listed below, where

1	2	3	4	5
Strongly disagree	disagree	Neutral	agree	Strongly agree

- 2.3. I am pleased with the pace of the ML curriculum 1 2 3 ④ 5
- 2.4. I am able to complete the curriculum each year 1 2 3 ④ 5
- 2.5. All the topics in the ML curriculum is necessary 1 2 3 ④ 5
- 2.6. The ML curriculum needs to include more topics, for example algebra & geometry 1 2 ③ 4 5
- 2.7. The ML curriculum is well suited to achieve the purpose of ML 1 2 3 ④ 5
- 2.8. The sequencing of the ML topics according to CAPS makes sense 1 2 3 ④ 5
- 2.9. I believe that mathematics learning helps learners to deal with real-life problems 1 2 ③ 4 5
- 2.10. I believe that ML is necessary because it will help learners solve real life problems 1 2 3 4 ⑤
- 2.11. In Mathematical Literacy, learners should first be taught mathematics content and then taught to deal with real life contexts 1 2 3 4 ⑤
- 2.12. A teacher needs a strong mathematical background for effective teaching of Mathematical Literacy 1 2 3 4 ⑤
- Any comment

MATHEMATICS CONTENT COVERED IN GRADE 8 AND 9

IS VERY ESSENTIAL FOR LEARNERS TO PERFORM WELL AT GRADE 10, 11 AND 12

The third thread concerned Njabulo's acknowledgment of the importance of real life demands and expectations in ML (another 11 of the 33 respondents agreed with him). He strongly agreed that ML supports learners to solve real life problems (another 18 of the 33 respondents strongly agreed with him). (See Figure 10.12.)

I asked Njabulo in the interview if he feels that having learners write an ML examination in their home language would be beneficial to them. He said that this was a discussion when he was completing his PGCE at UKZN five years ago. Having had this time to reflect on this matter, he feels that the contextual influences in ML will make the translation of the content to different languages very challenging. Njabulo asked, "Who will be having time to do this? There are some terms that cannot be translated, you see, to IsiZulu from English, so now if [a] learner is struggling with the concept, and it is explained in isiZulu, if [he or] she did understand it better, he or she will be able to perform better, but I do not think it will make much of a difference in mathematics especially or in ML . . . because each is a language, so if you can't do the arithmetic, whether it is in English or isiZulu [you cannot succeed]."

Njabulo raised the concern that textbooks and examinations are not at the same level. He elaborated further by indicating that the textbooks are not correctly aligned with examination questions. He expanded on this by stating that if you use only the textbooks and the examples in the textbooks, learners will not perform well in the examinations. Njabulo stressed that the ML textbooks are not good enough to prepare learners for the examinations. He stated that you have to use past examination paper questions to prepare learners for the style of examination questions used since the textbooks will not prepare them for the examinations.

Njabulo indicated that he believes that the contextual settings of ML questions are challenging for his learners. I observed that he used code switching to address this matter. He feels that he teaches more than just mathematics to learners when he is teaching ML, so he changes his strategies accordingly to support learners. He said, "When you have concepts that are challenging, you must try to befriend different methods or strategies like using visualisation, you know, or something that will make learners see or make them [become] hands on."

10.5 English and its relationship with Mathematical Literacy

Njabulo teaches his lessons in a mixture of English and isiZulu and uses more English than isiZulu in his code switching approach. He indicated that he did use more English than usual as the medium of instruction when I observed his lessons, but went on to say,

Normally I try by all means to use English since English is the medium of instruction and they write their exams [in English], so there are terms that [are] meant to be familiar to learners, so now if you are going to keep on using isiZulu you are going to disadvantage them and then they will have a challenge when it comes to exams.

Njabulo indicated that he believes that, since mathematics has its own language, there is a need to support learners in the language complexities of learning ML, so he confirmed that he uses isiZulu to reinforce concepts in teaching his classes. He believes that it is better to teach his learners in English and then isiZulu because “when you write an activity on the board or you are teaching, everything that you write is in English. If you start in IsiZulu, it is going to be a problem.”

Njabulo gives key phrases in isiZulu to confirm that his learners understand and grasp concepts. Several times in each observed lesson, he said to his learners “*Senza*.” Njabulo said that he does this in isiZulu so that learners are comfortable expressing themselves in his lessons. He said, “Sometimes you need to have something that you [use to] see if they really mean it. If you are going to rely on them saying yes, it’s going to be a problem.

Njabulo further indicated that learners struggle in the language used in ML examinations and assessments since “the actual words [are] an obstacle [for] learners. They need to understand the English first before they go to the language of mathematics you know, so that is what I consider [to be] a barrier. So, mathematics on its own is a language.” Njabulo agrees that the ML task language is also too overloaded with complexity. Njabulo supports this statement by indicating that “there is too much reading but there is no choice; ML is content with the real life activities. So, [this] needs to be explained.” Njabulo feels that to some extent the language he uses as the medium of instruction is detrimental to the learners’ progress in the class. Further to this, he tries to accommodate this struggle by using the language of the examinations, so he adapts the classroom activities accordingly. Njabulo said,

You know I will say when I do the activities I try to adopt the way they do it in the exam. Let’s say I am going to sketch a bar graph or teach sketching a bar graph and I just go there and put the numbers [in] and just put the question below. No! I try by all means to avoid that because when they come to the exam, what they find there is an instruction first. They have to read the instruction because there might be some information that is provided there before they [go] to the actual activity, so in terms of answering that question I will say it will be like disadvantaging them if you just [do] not provide all the information because when they come to an examination everything will be provided there.

This struggle with language used in the worksheets was illustrated for me by the use of the term “difference” in a question (see Figure 10.13). I asked Njabulo what he felt was the reason for the learners’ struggling with the term “difference” in these sets of questions. He said, “They can understand the word difference, but what they actually needed to do [presented] a challenge. Because the word is different in mathematics; when you say ‘difference’ it means you must subtract. . . Yes, so there are those terms in mathematics.”

Figure 10.13

Questions used in the observed lesson that need learners to understand what “difference” means in mathematical language.

- 3.3.2 Which age group has the smallest difference in the number of deaths between eThekweni and Tshwane? (2)
- 3.3.3 Describe the trend between the difference in number of deaths in each District. (2)
- 3.3.4 Determine the difference between the median of eThekweni number of deaths and median for Tshwane number of deaths. (6)

Njabulo noticed in reviewing past examination papers, that reading the wordy instructions becomes a barrier for the learners and hinders their performance in examinations. He said,

Looking at the past question papers, there is too much of the wording so learners need to read, read, read and then they go to the calculations and this thing of having too much of the wording is a challenge because for the learners in our community and our schools, English is their second language.

Njabulo was noncommittal in relation to the question about whether English second language learners and English first language learners both struggle with language in ML. He said that it is possible that there are several factors that could make an English second language learner outperform an English first language speaking learner in ML. He said, “Sometimes there are many factors that contribute to that. [It could] be a teacher, could be a learner, so, [yes].” However, he feels that second language English speakers battle with the complexities of ML language, so he reviews key words often with learners to have them familiarise themselves with these key words. He uses code switching to establish a link between speaking key words and writing them on the board in English. Njabulo said, “On that point, that is why I said that sometimes the learners struggle [with] the instructions. If they can get the instructions correct [while] understanding the content

knowledge, they can improve. Some other learners [can] understand the instruction but [not] understand the mathematics.”

10.6 Njabulo’s mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework

In this section I use the 4QCCDF outlined in Chapter 3 to identify how Njabulo supported learners with the challenges they experienced in the presentation of ML tasks related to the instructions and contextual attributes that feature in the contextualised tasks.

Firstly, Njabulo drew a graph’s axis on the board and in using academic results from Grade 7 to 12 and drawing them on the board, illustrated to learners how to complete a bar graph using a simple contextual scenario. Five sets of examination results ranging from Grade 7 to 12 were presented to learners. He said to the class, “Say, for example, I have a bar graph [draws the axis of a bar graph] showing the percentage of pupils’ passes in each grade.” After placing the results of the five grades on the bar graph, Njabulo then further expanded the illustration by adding the next year’s academic performance for these five grades and drew the double bar graph on the board for learners to see (see Figure 10.4). This example, that Njabulo presented to the class, is placed in Quadrant D since minimal contextual language was used, and the context of academic performance was familiar to the learners. Njabulo moved from Quadrant D to Quadrant C by simplifying the multi-step calculation into step-by-step simple calculations.

Following the example of two sets of academic results from Grade 7 to 12 being drawn on the board as a double bar graph, Njabulo introduced a new question about a farmer’s record of selling his produce over three days. To answer this question, learners had to draw a triple bar graph that used the sales record of the farmer that had been given. Njabulo said to the class, “Farmer Frank takes his produce to the farmers’ market every weekend. Below is the three-day record of the vegetables that were sold in pounds.” He then said, “*Did you understand?*” Njabulo drew up the axis on the board for the learners to copy into their writing books and he supported them, one by one, by observing them drawing the bars in their books. This is categorised as a Quadrant A task because the question is at an easier level of ML questioning with minimal steps needed to complete it. The contextual setting and rules for the question are simple. Njabulo moved from Quadrant A to Quadrant C by introducing new content in a contextual setting with identical mathematical demands. He broke down the information supplied in the question into manageable one-step calculations.

Question 3 is based on the recorded cumulative number of Covid deaths from two cities in South Africa. The question has a complex contextual setting, and the paragraph introducing the task is lexically dense (see Chapter 7.3). This question included a significant signifier, Covid, on which Njabulo elaborated because learners needed to know the meaning of this signifier as a dangerous disease from which many people died, to gain an understanding of the contextual setting of the question. The data is presented in a cumulative bar graph and a table. Learners needed to determine when to collect data from which source for each part of the question. Question 3.3 (see Figure 10.8) is categorised as a Quadrant B question because the contextual setting is complex and dense. Also, it could be complicated for the learners to extract the required information from the graph given in the question. Njabulo thus supported the learners by extracting the required information from the contextual setting. He said, “There are two key points in the question, eThekweni and Tshwane” (see Figure 10.8 and 10.10). The question demanded the learners to determine which age group had the third highest death rate from Covid on the double bar graph. Njabulo also identified the signifiers for the learners and supported them in identifying, step by step, the mathematical demand of the question. Njabulo placed emphasis on one of the signifiers, “the number of deaths”, to highlight that it is the number of deaths the question demands. This is the premise of the question, not the number of reported cases. Njabulo thus guided the learners to the mathematical demand of the question in his moving from Quadrant B to Quadrant C as he showed them that the mathematical demand is the extraction of information from a graph. Learners understood how to find the highest number of deaths. Njabulo asked, “Which age group has the third highest number of deaths?” and the learners responded with the highest number of deaths. Njabulo acknowledged this and then removed the contextual setting for the learners as he guided them through the steps of moving from identifying the highest number of deaths to the second highest and then to the third highest. He supported the learners in identifying the answer by emphasising the signifier of third highest number of deaths for this task. Njabulo said, “OK, let us understand the question first. *You start with the highest, then the second and then finally the third.* Let us start at the highest, so we will see what is the highest. He moved from Quadrant B to Quadrant C by removing the contextual setting and signalling the answer by identifying the signifier. Njabulo supported the learners in finding the answer to the question by guiding them in a step-by-step manner in determining the two highest death rates first on the double bar graph and leaving the last step to learners to identify and thus extract the required information from the graph.

Question 3.3.4 (see Figure 10.10) is categorised as a Quadrant B question. The task is a multi-step one that contains a contextual signifier, complex in nature, and dense contextual language. The question required learners to calculate the median of two different sets of data and to calculate the

difference between the two medians. Njabulo said to the class, “Determine the difference between the median, underline the word median, the word median. If you don’t know what the word median is, it is not going to be possible for you to answer the question. Am I correct?” Njabulo explained the meaning of the mathematical term median, then showed the learners where in the contextual setting of the task they could extract the necessary information. It was observed that Njabulo wrote the numbers of deaths for the nine provinces as recorded in the table of Question 3.3 (see Figure 10.9) on the board and the learners said the numbers out loud as he wrote them down (see Figure 10.9 and Figure 10.11). Njabulo then arranged the numbers in ascending order in a step-by-step manner, extracting the contextual setting from the mathematical demand and showing that the question is based on one-step calculations. He then showed the learners how to determine the median for each set of data and how to calculate the difference between them. Njabulo continually moved from Quadrant B to Quadrant C by removing the contextual setting of the task and by identifying the mathematical term median in the question for the learners. Njabulo then committed his time to work on the mathematical demands of the question in a step-by-step manner.

10.7 Conclusion

In this chapter I presented my findings on Njabulo the organiser, having collated the data from his responses in the questionnaire, from my observation of his lessons, and from my interview with him. I discussed his background and teaching environment to give an understanding of the teaching conditions with which he is faced. I present a transcript of the lessons I observed to provide insight into his teaching practice during his lessons. Then I considered his views in relation to ML and the ML curriculum. I considered his view of the reading, writing, and English skills of his learners to determine the relationship between success at ML and English language proficiency. I then considered his perspective and approach in terms of this study’s research questions. It was noted that Njabulo continually supported learners by identifying the contextual signifiers in questions, identifying the contextual rules in the contextual settings, and extracting the mathematical demands from the contextual settings and then breaking down multi-step questions into single-step calculations. He worked from Quadrants D, A, and B in moving to Quadrant C to support learners in effectively arriving at the solution in the classroom. Even though the questions Njabulo gave the learners in class could be categorised into different Quadrants of the 4QCCDF, he continually moved to Quadrant C to support them in the extraction of the contextual setting and in simplifying the mathematical demands into one-step calculations.

Chapter 11: The Rising Star

11.1 Introduction

In this chapter, I present my findings about the teacher I decided to call Sindisiwe, the rising star. These include the findings from responses to the questionnaire, my observation of her lesson, and my interview with her. I refer to how Sindisiwe interprets ML and her opinion on the challenges she faces in teaching ML. I conclude with my findings on how she feels about English and its relationship to ML. The aim of this analysis was to determine whether Sindisiwe believes that there are language demands associated with the learning of ML.

11.2 Background of the participant and her teaching environment

Sindisiwe is a teacher in her mid-twenties who teaches only ML. She said that at her school, teachers are given only one grade to teach so that they can specialise in a specific subject at a specific grade level. Sindisiwe teaches all the Grade 10 ML classes in the school. She is a newly qualified teacher with a PGCE and is trained to teach mathematics and technology. She volunteered to teach ML and has taught for only one year so far. She is an isiZulu speaker who attended a school that uses English as the medium of instruction but is isiZulu oriented. She agrees that she is proficient in speaking English (see Figure 11.1) and believes that as a teacher such proficiency is essential. Sindisiwe said,

The only thing you need to understand is English, then from there you will know how to analyse and how to get answers, so they moved me to teach ML (I think it was a good move personally) so then I just teach [this]. There [are] no barriers for me. The only thing is to read and analyse and we will get the answers.

Sindisiwe teaches in a quintile 3 resourced school in KwaMashu, northwest of Durban city. The lessons I observed were in a Grade 10 class and Sindisiwe said that there were Sotho, isiXhosa, and IsiZulu speaker in the classroom. Although inexperienced, her demeanour in the classroom was very professional and she was calm and controlled. The learners were attentive during the observed lessons, and she displayed very efficient classroom managerial skills.

Sindisiwe stated in her interview that she has to display great levels of classroom management. She said, “I have to. I have to be in between them, because they should pay attention to me as I am the one who is explaining.” She further indicated that a challenge for her in teaching in this

environment is the language barrier. For her, “the language barrier [is] so difficult. Th[e]se learners, they don’t understand English, so you have to explain in English and then you have to elaborate in isiZulu.” I observed that she used only isiZulu for disciplining learners and when I asked her about this in the interview, she responded, “I have to discipline them in isiZulu so that they can understand what I am saying. If I [use] English, they do not even understand the question papers and questions, [so] how can [they] understand me when I am disciplining them? So, this is why I discipline in isiZulu.”

Figure 11.1

An extract from the completed questionnaire Sindisiwe submitted in relation to her thoughts about her own English proficiency.

3.2. I am very proficient in speaking English

1 2 3 4 5

11.3 The observation notes

I observed Sindisiwe teaching two Grade 10 ML lessons and the class consisted of more than 40 learners, most of whom were isiZulu speakers with some isiXhosa and a few Sotho speakers. She addressed the complexities of teaching a class whose learners do not speak English as a first language by using code switching to support them in understanding the challenges presented in ML.

There were distinct patterns that were obvious to me during these observed lessons. Sindisiwe used code switching as a medium of instruction very effectively and when necessary to make key words intelligible to the learners and to create a link between isiZulu and English. She identified the key words in a question and emphasised these key words to help enable her learners to identify the mathematical demands in them. I noted, too, that she used minimal resources to teach her lessons effectively.

Sindisiwe printed out past examination paper questions and handed them out to the learners who completed them and then she and the learners corrected the work through her explanations on the board. She selected the questions according to the learning objective that was set for the day. She gave the learners time to engage with the work, so for long period of times she was busy supporting

learners as they were completing the tasks. She requested me not to record the observed lessons, so I offer my observation notes¹⁹ from the two lessons here.

The first observed lesson was a Grade 10 ML lesson with more than 40 learners in the class. The objective of the lesson was to revise for exams using printed examination questions that were focused on map work. The questions were handed out to the learners and Sindisiwe checked that the learners had books on their desks and that they were ready to work. She indicated that she would love to have a projector because the question for the day was based on maps, and it would be beneficial to display the map this way. While she was saying this, she placed the worksheet on the board (see Figure 11.2).

Figure 11.2

Sindisiwe placed a copy of the worksheet on the board given the limited resources available to her.



Sindisiwe revised the identification of the nine provinces and checked the learners' understanding of how scale operates in a map. She established their ability to name the countries that neighbour South Africa and checked that they could name the capital city of each of the nine provinces. She also revised compass directions with the learners, having them indicate north, east, west, and south on a map (see Figure 11.3). Sindisiwe used all this as her introduction to the map work in Question 2.1 (see Figure 11.3). The learners raised their hands in response to her questions and Sindisiwe asked only those who had done so. The learners engaged very well with the questioning process. They were all very polite during the lesson and very enthusiastic in their responses to her style of questioning. Sindisiwe read out every question, she identified the key words, and explained the

¹⁹ I have changed the tense of these notes and have edited them slightly in the interest of coherence.

definition of each. She then had the learners raise their hands and attempt to answer these. Sindisiwe supported the learners by writing the corrections on the board.

Figure 11.3

Sindisiwe asked question 2.1 during the observed lesson from National Senior Certificate Grade 10 past examination papers.

2.1 Refer to the map of South Africa below and answer the following questions

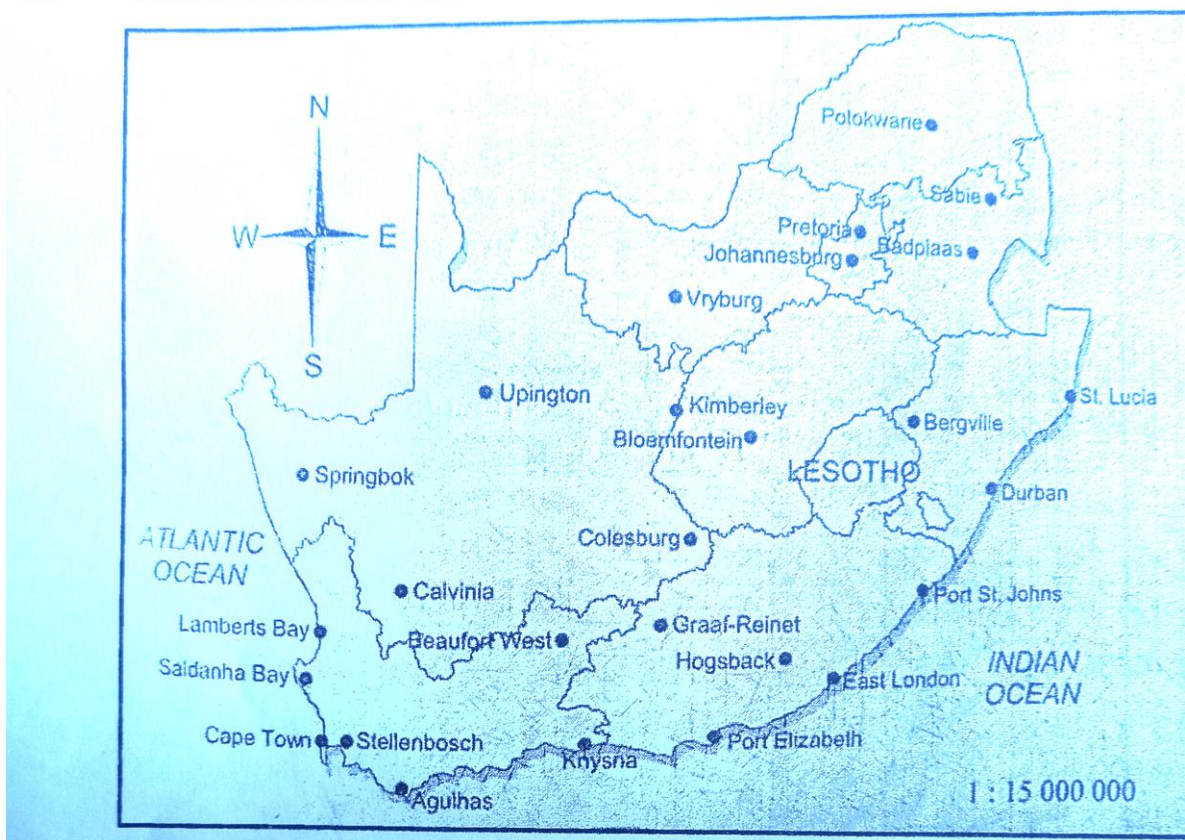


Figure 11.4

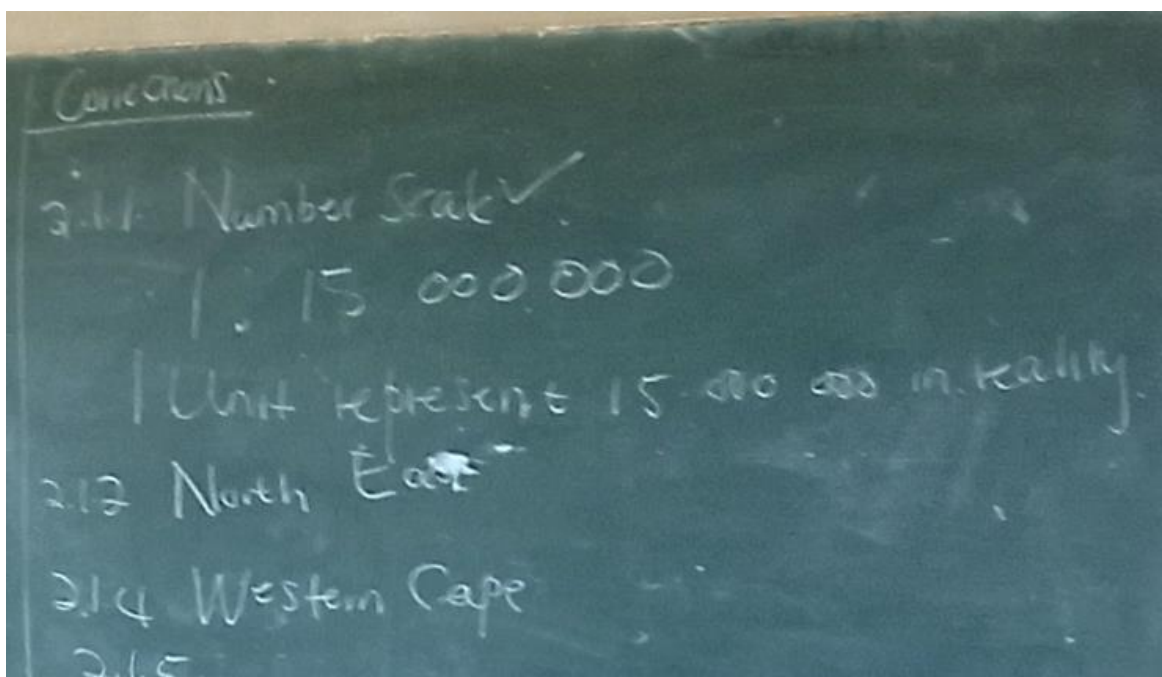
Below is Question 2.1.1

2.1.1 What type of the scale is given in the diagram and interpret the given scale?

Sindisiwe discussed with the learners the relationship between measurement on land and measurement done to scale and converted the scale readings to kilometres (see Figure 11.4) in a step-by-step process (see Figure 11.5). As she explained the key words, she repeated the definitions, and the learners repeated them together with her.

Figure 11.5

Evidence of the answers Sarah supplied the learners in the class.



Learners were then asked individually to answer questions aloud as they raised their hands. Sindisiwe focused on a question that required learners to identify the direction of one town relative to another. She placed emphasis on the key word, from, that complicated the question for the learners (see Figure 11.6). The learners were confused about which town to measure the direction from since they were confused by the word “from.” Some learners answered the question by about the direction to Badplaas from Colesburg and some learners did so from Badplaas to Colesburg (see Figure 11.6). Sindisiwe illustrated the difference between the two terms, from and to, and how answers to them would differ. She gave the learners another example and a question that used the key terms from and to.

The first time Sindisiwe did not use English as the medium of instruction I noted that some learners became disengaged. (She disciplines in isiZulu, as mentioned above.) She then emphasised the

importance of understanding the English in the question. She explained later to me that “learners understand the directions and know how to identify them, [they] just struggle identifying the point [from which] to start.” Sindisiwe did not rush through the questions; meticulously, she took time to make sure that the learners grasped the mathematical demands of each.

Figure 11.6

Below is Question 2.1.2

2.1.2 Write down the general direction of Badplaas from Colesburg

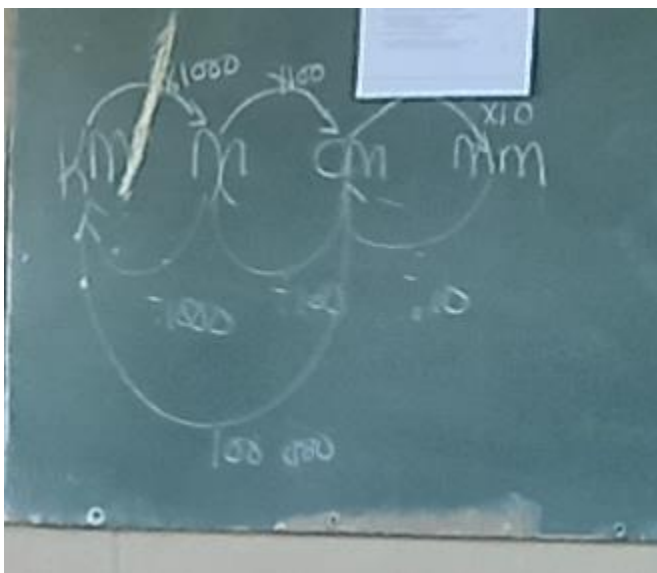
Figure 11.7

Below Question 2.1.3

2.1.3 Use the given scale and determine the actual straight-line distance between: East London and Bloemfontein.
Show ALL calculations and give your answer in km.

Figure 11.8

Evidence of a conversion table used by Sindisiwe to convert units in measuring.



Walking among the learners in the classroom, Sindisiwe made sure to check that they were measuring the distance between East London and Bloemfontein correctly with their rulers. When Sindisiwe completed corrections on the board, she wrote down every step and had all the learners go through each one together as she guided them to the answers. She asked probing questions as part of this process. Most learners said the correct answers out loud. Sindisiwe revised with her learners the process of converting centimetres to kilometres by displaying a step-by-step illustration for them (see Figure 11.8). Learners shared calculators to arrive at the correct answer. Sindisiwe asked a learner for an answer, and she replied in a quiet and shy tone of voice. Sindisiwe told her to be enthusiastic. She said, “When you go home you will say loudly, ‘I want my food.’ But [here] in class you say the answers softly.” Some learners said loudly as a joke, “I want my food.” Sindisiwe and the other learners laughed, then Sindisiwe brought the class to order, and the learners went back to completing their corrections.

Figure 11.9

Below Question 2.1.5

2.1.5 What is the probability that this province will be randomly selected in South Africa? Write your answer correct to TWO decimal places.

Sindisiwe read out the next question that asked in what province Stellenbosch is located. The class unanimously said “Western Cape” out loud. Following this she turned to the next question: What is the probability that this province will be randomly selected in South Africa? Write your answer correct to two decimal places (see Figure 11.9).

Instead of Sindisiwe giving the answer directly, using correct key words and terminology, she wrote the theoretical probability format out for the learners to use.

$$PE \text{ (Probability of event occurring)} = \frac{\text{Possible outcome}}{\text{Total outcomes}}$$

Sindisiwe initiated a discussion with the learners to determine how many possible outcomes there could be. The learners said, “Nine.” Sindisiwe then asked in how many provinces Stellenbosch is located. The learners all said, “One.” She then displayed the answer in a fraction.

$$\frac{1}{9}$$

She asked learners to convert the fraction into a decimal on their calculators and to round the answer off to two decimal places.

Figure 11.10

A question used during an observed lesson.

The principal of the Fisokuhle School is looking for sponsors that are going to develop his School. He uses the map below to show the potential sponsors how he wish his school to look like.

The school Map

School Map (1st floor)

SCALE 1:2 000

[Source: www.wikihow.com]

Use the map above to answer the following questions:

3.1.1 Miss Radebe is at the gate next to grade 1 and her next period is in grade 7. Describe the shortest route from the gate to the class. (4)

When this was done, Sindisiwe handed out another worksheet with a question about map work from a past paper (see Figure 11.9). The question was based on a school map. Before Sindisiwe read out the question, she repeated twice to the learners, “When you read a question you must read with understanding.” When she said this for the third time, the learners said it out loud with her.

Sindisiwe then indicated to the learners that they must highlight key words in the question. She identified the key words in question 3.1.1 for them (see Figure 11.10). While she was supporting the learners, Sindisiwe said several times, “Master the English, please.” The learners were given the last 12 minutes of the lesson time to complete Question 3.1. As the learners engaged with the work, Sindisiwe walked among them to determine their understanding of its requirement, and to support learners where necessary.

11.4 Views of Mathematical Literacy and the curriculum

Throughout Sindisiwe’s interview, her core emphasis was on the need for English proficiency in the learners if they are to succeed in ML. She stated that she thinks there is a difference between ML and mathematics as subjects. For her, “ML is so [much] easier [because] you just need English and mathematical knowledge. Mathematics is very difficult; [it] requires more and more effort.”

Sindisiwe also indicated that she feels the content of the two subjects are not similar. When I asked her how she thinks her learners experience the ML curriculum, she indicated that she has to guide them in the classroom and so, when the learners are working in the classroom they perform well. However, “When I’m not around, they forget everything. They just forget everything, for example, in exams.”

There were three threads that arose from Sindisiwe’s views of ML and the curriculum according to her replies to the relevant Likert scale questions in the questionnaire (see Figure 11.11). The first thread was her agreement with the pace of the curriculum (another 14 of 32 respondents agreed with her) and her agreement that the ML curriculum can be completed in an academic year (another 12 of 33 respondents agreed with her). Sindisiwe strongly believes that learners should be taught the mathematical content in ML before the real-life context is introduced (another four of 33 respondents agreed with her).

The second thread contradicts her earlier response given Sindisiwe’s positive views on the curriculum and its content. Sindisiwe is satisfied with the current topics in the ML curriculum. She agreed with the necessity of the topics in ML (another 23 of 31 respondents agreed or strongly agreed with her), strongly agreed that the curriculum is well suited to achieve the purpose of ML (another 23 of 31 respondents agreed or strongly agreed with her) and strongly agreed with the sequencing of the ML topics according to CAPS (another 21 of 33 respondents agreed or strongly agreed with her). Sindisiwe strongly disagreed that ML needs more topics such as algebra and geometry (along with another 14 of 33 participants).

The third thread was Sindisiwe's acknowledgment of the importance of real life demands and expectations in ML. Sindisiwe strongly agreed that ML supports learners in solving real life problems (another 18 of 33 respondents agreed with her) (see Figure 11.11).

Figure 11.11

Below is an extract from the completed questionnaire Sindisiwe submitted regarding her opinions about ML.

Using the following scale of 1-5, use a number to indicate the degree to which you agree with the statements listed below, where

1	2	3	4	5
Strongly disagree	disagree	Neutral	agree	Strongly agree

2.3. I am pleased with the pace of the ML curriculum	1 2 3 ④ 5
2.4. I am able to complete the curriculum each year	1 2 3 ④ 5
2.5. All the topics in the ML curriculum is necessary	1 2 3 ④ 5
2.6. The ML curriculum needs to include more topics, for example algebra & geometry	① 2 3 4 5
2.7. The ML curriculum is well suited to achieve the purpose of ML	1 2 3 4 ⑤
2.8. The sequencing of the ML topics according to CAPS makes sense	1 2 3 4 ⑤
2.9. I believe that mathematics learning helps learners to deal with real-life problems	1 2 3 ④ 5
2.10. I believe that ML is necessary because it will help learners solve real life problems	1 2 3 4 ⑤
2.11. In Mathematical Literacy, learners should first be taught mathematics content and then taught to deal with real life contexts	1 2 3 4 ⑤
2.12. A teacher needs a strong mathematical background for effective teaching of Mathematical Literacy	1 2 3 4 ⑤

Sindisiwe made the learners name all nine provinces and their capital cities. When I asked her why she did this since it was not in any of the questions presented in the worksheet, she said,

It was [because of] the topic, maps, and scales. I have to teach them provinces, I have to teach them capital cities, I have to tell them [what] national roads [are], because the

questions came from [past] exams. I also have to teach them [about] directions, yes, so when the question comes [an] Eastern Cape map [will be given] and from there they will ask, ‘What is the capital city? What is the national road? In which province is Bisho City?’ I just need to tell them everything.

I asked Sindisiwe about her methodological approach and how thorough she is when teaching a topic to learners. She said that she will go over and above what is asked of learners in the worksheet. She pre-empts other possible questions that can be posed to learners by giving them all the information they will need. Sindisiwe indicated that this is necessary when she said, “Yes and [maybe] that map also comes with the scale. [Perhaps] they have to calculate the median? [They give] a bar scale, a ratio scale, then from there [they] have to calculate the actual distance [for example] from Pinetown to Durban, then [they] must use the map and at the same time [they] must use the scale.”

Sindisiwe was very illustrative in her teaching approach. She displayed in a step-by-step manner how to convert from centimetres on a map to kilometres in real-life (see Figure 11.8). When I asked why she offers such a thorough explanation, Sindisiwe explained that if she does not do so, learners will forget how to solve the problem [and answer the question.] “I need to explain and then I must write [down] what I am saying, because when I only explain, they [will] forget. When I only explain, they forget, so I must explain and I must write [it down on the board].”

Sindisiwe informed me that she struggles with the complexities of the contextual challenges in the ML curriculum. When I asked about it in the interview, she said,

You don’t know. When the [exam] paper comes, it comes with loads of questions you have [not] expected [so] you have to explain out of the box. When you are with learners, you must explain everything, even the thing that is not needed, but when the [exam] paper comes, what I [have been] explaining [will] actually [be] needed, so that is why I have to explain everything, even though I can see it is not needed [in a particular preparation question] I have to explain so they will know.

Further to the contextual challenge, Sindisiwe feels that the textbooks are not sufficient to prepare learners for the different scenarios in which a ML topic can be examined. She said, “No, the textbook is there only for the educators to see the topics and then to take the key information they need from there. You must link your questions [to] the [possible] question paper.” She supported this with an example: “[When] I was doing the finances, I had to check the past papers with [similar] questions, so the learners will know how to answer the questions.” Sindisiwe does feel that the ML examinations are too complex and that they are overloaded with context.

11.5 English and its relationship with Mathematical Literacy

Sindisiwe felt very passionate about the correlation between the learners' English proficiency and their ability in ML. When asked about the challenges that she faces in teaching ML, she indicated that she reads the question out in class in English to the learners and notes that not all learners grasp the meaning of the question. "Some of them [will] respond and [for] some of them, you can see that they can't answer. It's the language barrier." Sindisiwe offered an example of an experience she had had the day before when she said, "I just gave them the work [with shopping] slips, they analyse[d] the slip and they asked me 'What is purchase?' I just [told] them that [to] purchase [means] to buy [something]. In isiZulu [a similar word is] *umthenga*, so they will recall this each and every time they see the [word] 'purchase.'" Sindisiwe uses code switching for consolidation in the learning of key words and phrases in ML. She said that because there are several languages spoken in her classrooms, she uses isiZulu because "isiZulu and isiXhosa are [similar], [and the] Sotho [learners], they also understand IsiZulu. So, I think it's easier [to use] isiZulu because all of them speak [or understand] isiZulu." Sindisiwe feels that because so many languages are spoken in her classroom, code switching is necessary to make sure that the message is conveyed effectively from teacher to learners. This was evident in the lessons I observed; Sindisiwe always read the question in English then said it in isiZulu to clarify the concepts in the ML questions.

Sindisiwe also paid attention to the learners' reading skills and abilities. She indicated that the learners struggle in the examination because they struggle to grasp what the questions require of them. They struggle to extract the correct information from the questions because of their lack of reading skills. She said, "Sometimes they fail because I am not in front of them to elaborate." I observed her use of the term "read with understanding." When I asked her about this she responded,

I always tell them for ML, whatever you do, you must read with an understanding, you must read so that you understand. If you do not understand, you must maybe read [a question] three times, so that you can be able to analyse the statements, in order for you to answer the questions.

Again, in the context of reading skills, I also observed Sindisiwe's use of the term "master the English." She explained, "They must master the English. If [they] master the English [they] will understand the question, [they] will understand the scenario, [they] will know and analyse better and [accurately], [and will] answer everything correctly."

Sindisiwe felt that the language of mathematics has an effect on her teaching and on the learners' ability to perform adequately in ML. She said, "I think yes, because in ML you have to convert. That is [the] language of mathematics; you have to convert the units, in mathematics [you do not]

convert, but in ML you convert so you must tell them that conversions is a ML phrase.” She does feel, however, that the language used in the ML examinations and curriculum is adequate, but states that the learners must learn to communicate in English as a language. Further to this, I asked Sindisiwe if she thinks it would benefit learners to have them examined in their home language. She indicated that the translation for examination purposes would be very challenging because of language issues. She said, “In an isiZulu paper [the translation is so elaborate that the paper] will [have to] come as a pamphlet.” By “pamphlet’ Sindisiwe means a much longer paper.

Sindisiwe revealed in the interview that she advises learners to use technology and news publications to improve their English. She explained that “on the television, there is a channel for learners [that is] in English. There is English, physics and [all other subjects], so they have to watch the channel and learn, not just [listen to] the music. [They] must read the newspapers in English and when they [encounter a] name or phrase that they are struggling with, [they] must ask, ‘What does this mean?’” Following this statement, I asked Sindisiwe if she thinks learners who speak English as a first language and those who speak it as a second language both struggle in ML. Sindisiwe was unsure about how to answer this question, but, after reflecting on the matter, she said that her learners are predominantly isiZulu speaking. She mentioned a school that has mainly so-called Coloured learners [who] come from Hillview, and, although they struggle, they [perform] better.” (The learners she refers to HERE are English speaking). Sindisiwe also stated that she feels that learners struggle in ML because of many factors, including limited English proficiency and that the language she uses in the classroom influences the learning that happens there.

11.6 Sindisiwe’s mediation in terms of the Four-Quadrant Contextual and Cognitive Demands framework

The 4QCCDF is used to identify how Sindisiwe supported learners with challenges presented in ML questions that use complex language and contextual settings that are unfamiliar to them.

Such was the case for Question 2.1.2 (see Figure 11.6) since learners were required to determine the direction from one town to another using a map. The question asked for the general direction of Badplaas in relation to Colesburg. The question was placed in a contextual setting that required an understanding and identification of the signifier in order to arrive at the correct answer. The term general direction is a specialist mathematical term in the context of the question, and it contains a special meaning in this question. Sindisiwe supported the learners with the contextual language in the question as they struggled to identify if they had to determine the general direction to or from the town of Colesburg. Sindisiwe said, “Learners understand the directions and know how to

identify them, [they] just struggle identifying the point [from which] to start.” She illustrated the difference between the two contextual terms in the question, to and from, and gave the learners the correct answer to the task and then used the same contextual setting to give the learners another task to complete using both terms, to and from, by selecting two different towns on the map. Sindisiwe thus stayed in Quadrant A by using an alternative task in the same contextual setting to support learners in understanding the contextual language used in the question. She simplified the mathematical demand by extracting the contextual setting and the complex terms used so that the learners could use a single-step determination of a general direction between two towns on the map in moving from Quadrant A to Quadrant C.

Question 2.1.5 (see Figure 11.9) required the learners to determine the probability of randomly selecting the Western Cape as a province in South Africa. The question contains complex contextual language and consists of simple calculations. This places the question in Quadrant A. Sindisiwe supplied the learners with the formula of how to display the probability, elaborating on the mathematical terms that are placed within the formula. She pointed out to learners the possible outcomes and the total outcomes. With this support, they could identify the possible and total outcomes and present the answer as a fraction. Sindisiwe then supported the learners in the mathematical conversion of a fraction to decimals since the question required this conversion. She removed the contextual language from the question to make the calculations to the questions simple and based on a one-step calculation, thus moving from Quadrant A to Quadrant C.

Question 3.1.1 (see Figure 11.11) is categorised as a Quadrant B task with a contextual setting that contains multi-step questions. Sindisiwe moved from a question in which general directions are to be determined and simplistic straight-line directions are determined using a scale, to a more complex map of a school in which multi-step questioning was given, thus moving from Quadrant A-based questions to Quadrant B-based ones. Thus, the context is similar to the previous question because Sindisiwe determined that her learners are accustomed to the contextual setting that is accompanied by signifiers and complex language so she gave learners a similar context that is, however, more complex in meaning. The new question was based on a school map (see Figure 11.10). The question required learners to identify the shortest route from one classroom in the school to another using the scale provided. Before Sindisiwe read out the question, she repeated twice to the learners, “When you read a question you must read with understanding.” When she said this for the third time, the learners said it out loud with her. Sindisiwe then indicated to the learners that they must highlight key words in the question. She identified the key words in the question for the learners, thus eliminating the contextual setting and having learners determine the mathematical demand in one-step calculations. Sindisiwe, therefore, moved from Quadrant B to Quadrant C as

she removed the contextual setting and left the learners with the calculation of the mathematical demand to contend with.

11.7 Conclusion

In this chapter I presented my findings on Sindisiwe, the rising star that I collated from her replies to the questionnaire, my observation of her lessons, and from my interview with her. I discussed her background and teaching environment to offer some understanding of the teaching conditions that she faces. Since she chose not to have her observed lessons recorded, I offered the notes I took while I was observing her. Following this I explored her views on ML's curriculum and ML's relationship with English in the light of her view that ML learners must master English if they are to do well in the ML examinations. I determined her perspective on, and approach to, this study's research questions. Sindisiwe was observed using the 4QCCDF and it was noted that she continually supported learners by identifying the contextual signifiers in questions, extracting the mathematical demands from the contextual settings, and breaking down multi-step questions into single-step calculations. Sindisiwe explained tasks in a step-by-step manner thus simplifying mathematical tasks into one-step calculations and thus moved from Quadrant B to C for certain questions, from Quadrant D to C for some, and from Quadrant A to C for the remaining ones. Thus, she worked continually by moving from Quadrants D, A, and B to Quadrant C to support learners to arrive at the solution to the questions presented in the classroom. On a rare occasion, Sindisiwe was observed staying in the same quadrant as she used another contextual signifier that could be used in the same contextual setting and gave learners the opportunity to answer a question with the newly introduced signifier, thus giving them the understanding of how both signifiers work in a contextual setting. Even though the questions Sindisiwe gave the learners in class could be categorised into different Quadrants of the 4QCCDF, she continually moved to Quadrant C to support them in the extraction of the contextual setting and in simplifying the mathematical demands into one-step calculations.

Chapter 12: Research findings, conclusion, and recommendations

12.1 Introduction

In this chapter, I present the findings of my research study and show how these findings address and answer its research questions. I used the data collected from the questionnaires, the lesson observations, and the in-depth interviews to answer the research questions. In my study, I intended to explore teachers' perceptions of, and responses to, the language demands associated with the learning of ML. I addressed this by identifying teachers' perceptions about the challenges learners face in coping with ML. I then identified the strategies that teachers implemented to support learners in dealing with these challenges in contexts in which they have to bridge the gap between the contextual settings and mathematical demands in ML examination and test questions. Participants indicated the kinds of support they need to help their learners bridge the gap between the contextual settings and mathematical demands in ML questions.

12.2 Description of participants

Table 12.1

A short description is used to describe the participants that were observed and interviewed for this research study.

Jan the Mentor	Nothando the Code Switcher	Sarah the Leader	Bridgette the Kind One	Njabulo the Organiser in which	Sindisiwe the Rising Star
- Mid-thirties - Male 12 years' teaching experience - Teaches ML and mathematics Core - Well-resourced school - No code switching used - Second language English speaker	- Mid-thirties - Female 14 years' teaching experience - Teaches ML - Under-resourced school - Code switching is used - Second language English speaker	- Mid to late-forties - Female 25 years' teaching experience - Teaches ML - Well-resourced school - Code switching is used - Second language English speaker	- Late-thirties - Female 10 years' teaching experience - Teaches ML - Well-resourced SEN school - No code switching is used - First language English speaker	- Mid-thirties - Male 13 years' teaching experience - Teaches ML and mathematics Core - Under-resourced school - Code switching used - Second language English speaker	- Mid-twenties - Female 1 year teaching experience - Teaches ML - Under-resourced school - Code switching is used - Second language English speaker

12.3 Research question one

What are teachers' perceptions of the learners' struggles with the language complexity in ML?

For the first stage of data analysis, I used the questionnaires to obtain an overall picture of teachers' perceptions of the learners' struggles with the language complexities in ML. The second stage of the analysis involved using data gathered from the questionnaires, lesson observations, and in-depth interviews to develop narrative descriptions of the six teachers. This second stage allowed me to develop an in-depth understanding of the teachers' views of the language complexities in ML and the ways in which they sought to ameliorate the difficulties associated with this language factor. Now, in this third and final stage of data analysis, I present a cross-case analysis of the six teachers' narrative descriptions to present answers to the research questions, supported, where necessary, by the data from the larger group who responded to the questionnaires. From answers to the three research questions, five themes emerged from the results (presented in Chapters 5 to 11) as shown below.

12.3.1 Teachers believe that to do well in Mathematical Literacy, learners need to be proficient in English.

From the questionnaire responses, it was clear that many teachers felt that English language proficiency played a big role in learners' performance in ML. Table 5.2 in Chapter 5 indicates that 56% of the teachers from well-resourced schools felt that learners who did not speak English as a first language were disadvantaged, while 78% of the teachers in under-resourced schools felt the same way. These results show that teachers believe English language proficiency is associated with learners' successful performance in ML. Many questionnaire comments show support for this belief; Participant AH stated "ML and English are twins. You cannot have ML without English . . . ML needs learners to understand English" and Participant W said that [the lack of English language proficiency] is one of the main contributors [to] learner[s] failing mathematics." The narrative chapters also provide support for this view. Sindisiwe indicated that understanding English is the single most important component in performing optimally in ML. She stressed to her learners that they must master English as she read each question aloud during the observed lessons. Sindisiwe emphasised that her learners need to gain a level of English proficiency to grasp the requirements of the contextual settings. Sarah supported Sindisiwe's statement by indicating that learners who have a clear understanding of English do have an advantage. Njabulo's views were similar; he said, "There is too much of the wording, so learners need to read, read, read and then they go to the calculations and this thing of having too much of the wording is a challenge because [for] the learners in our

community and our schools, English is their second language.” Nothando made similar comments about the relationship between ML and language. Jan felt that the important issue was not English language proficiency so much as the comprehension of key words because he had “seen learners perform above their weight, 100%, and it is purely because they snapped the simple thing that the question asked, and it is not because they necessarily had the comprehension, but they understood what the question asked based on the key words.” For him, it was not a simple matter of language proficiency but of being able to identify the key words that made a difference to whether learners got the answer correct.

Many studies have raised concerns that learners who are not proficient in English may be disadvantaged in mathematics (Reddy et al. 2016; Robertson & Graven, 2019; Spaul, 2016) and particularly so in ML where studies have emphasised that language can act as a barrier to learners’ engagement (Bansilal & Khan, 2013; Bansilal & Wallace, 2008; Maluleke, 2019).

12.3.2 There are various language complexities that all Mathematical Literacy learners have to navigate

The analysis of the questionnaire responses showed that teachers believe that the language used in ML topics and tasks is quite complex. For Participant M, “ML uses the language . . . and Mathematics uses formula” and for Participant P, “ML involves a lot of language and making sense.”

The teachers who were interviewed claimed that ML involves working with language more than with mathematics. Sarah believes that ML does not have a language of its own and that it is complex. For her, “It is a language from all the different subjects it has stolen from, bit[s] of mathematics, accounting, geography and English” that learners need to grasp. Jan indicated that learners struggle with complex language used in ML examinations and lamented that “the scary thing is when they write an exam, the hands shoot up, I cannot help and I cannot help them and I look at the examination paper and I say, ‘Damn, I don’t even get it’.” This, as he pointed out, presents several complexities for the learners. Sindisiwe noted that one needs to be able to communicate in English to succeed in ML examinations. Jan supported this statement by indicating that the lack of English comprehension skills constitutes a barrier to learning. He further elaborated that English language comprehension plays a larger role in learners’ struggling in ML than limited mathematics knowledge. Bohlmann and Pretorius (2008) conducted a research study that suggested that English reading is strongly supportive of mathematics achievement in South Africa. Learners need to first understand and comprehend English as a language before they can deal with the

complexities of ML terminology. Ayca (2022) identified that reading skills are needed to comprehend mathematical texts and word problems in mathematics. Most participants agreed with Sarah that ML is a language in itself.

Jan and Nothando believe that first and second language English speakers struggle with the language demands in ML (see Barwell, 2005; Opitz and Schindler, 2021) and Nothando believes that first and second language English speaking learners' struggles are not similar. Bridgette believes that getting learners to read questions aloud in the classroom can help them practise and improve their English vocabulary and the reading skills that are required for ML. Bridgette further explained that she reads questions out loud because four languages are spoken in her classroom. She enforces this strategy because in a SEN school learners tend to shy away from reading and want to rely on having teachers read questions out loud to them.

Sarah read the questions out loud to her learners to elaborate on critical aspects in them. She consistently reminded the learners that they needed to read the question to determine the contextual setting if they were to gain an understanding of it. She explained that the information required for successful implementation of a ML question is in the wording of the question so, for her, reading the questions aloud would be advantageous to learners. These skills are required, as Njabulo and Sarah pointed out, because the ML task language used in questions is too overloaded with complexity. Bansilal and Wallace (2008) determined in their research findings that the task language used in Grade 9 mathematics CTA that is administered in South Africa prohibited learners with poor English skills from understanding the context of, and the instructions in, the tasks.

12.3.3 Mathematical Literacy learners for whom English is a second language experience additional difficulties in dealing with the language complexities in Mathematical Literacy

Table 5.2 in Chapter 5 indicates that 73% of the teachers felt that learners who did not speak English as a first language were disadvantaged in a ML classroom. A similar sentiment is expressed in Table 5.3, in which it can be seen that 73 % of the teachers agreed or strongly agreed that English second language ML learners struggled to answer test and examination questions because of their poor English language skills.

In the open responses section of the questionnaire, Participant Q noted, “[For] almost all of them their home language is IsiZulu [and] that is why they do not understand some of the ML problems.” A similar comment was made by Participant W who wrote that “[second] language learners struggle with grammatical contexts of questions and minor nuances in the language that change the emphasis of the question.” For Participant V, English second language learners faced further problems with

the specific language used in ML: “Terminology used is one of the biggest problems [for] our learners [because] most of the problems are scenarios that [need] learners to understand before they [can] answer.” These participants raised the point that second language learners have an additional hurdle of mastering English terms as well as becoming familiar with the ML register that has its own specialised language, rules, and reasoning as described by Bansilal and Debba (2012).

Many of the interview participants made similar comments about the specific difficulties faced by English second language learners. Sindisiwe felt that although there were several factors that contribute to learners struggling in ML, language is a prominent one. She felt that one problem that her second language learners faced was becoming familiar with the text used to describe the scenarios as well as that in the instructions of the task, so she spent time getting her learners to call out the words aloud and to repeat them so that they could recognise their meaning and their significance to the problem. Sarah, in her interview, said that the struggle of first and second language speakers was different in that the “first language [speaker] needs to grasp mathematics, second language [speaker] needs to grasp the mathematics and [the] language” and this is a double challenge.

Bridgette felt that her learners were further disadvantaged since they had special learning needs as well as, for example, poor reading skills. She read out text aloud and asked her learners to read out aloud, because they need to hear the words and numbers, as was evident in the case of a learner reading 48.608 as 48 point 6 hundred and 8, instead of 48 point 6 zero 8. As a second language English speaker himself, Jan was sensitive to the challenges faced by English second language learners. He felt that comprehension of the English language in ML is an issue especially for second language English speakers.

These participants’ comments highlight the additional hurdle faced by learners trying to deal with specific English language nuances while also trying to understand those of the specific ML register. This issue has been raised by scholars such as Jourdain and Sharma (2016) who noted that learners who do speak English as a home language have to contend not only with the vocabulary challenges in the register of mathematics, but also with the change of meanings between registers.

12.3.4 When the contextual setting is not familiar to the learners, it places additional demands on them

Participants indicated that their learners struggle with ML questions when the contextual setting is unfamiliar to them. Teachers’ responses to the questionnaire highlighted this issue. For example, Participant X said that the context presents different challenges to learners depending on whether

they have a rural or urban background “because they don’t interpret contexts in the same way.” Jan stated that the contextual setting has a language of its own. For Nothando, there are serious gaps in her learners’ learning in ML because of the challenges contextual settings present to them in being unknown or unfamiliar to them. Jan stated that the link between language and real life ML applications is of a contextual nature as in finance documents, for example, since most learners would not see these every day.

Njabulo indicated that he supports his learners in dealing with language complexities in ML by adapting his lessons to make the contextual setting more approachable to them. Nothando indicated that because her learners struggle to familiarise themselves with the contextual setting, she identifies vital phrases or key words in the question, reads them out in English several times to emphasise their importance and then code switches to make them more understandable in a familiar language. Botha and Putten (2018), identified in their research findings that ML learners prefer to go straight to the mathematical demand and skip the contextual setting. To combat this, Nothando identifies vital phrases or vital key words in the question, reads them out in English several times to emphasise their importance and then code switches to make them more intelligible in a familiar language. Bridgette indicated that since the ML curriculum and questions are context-based, she asks learners probing questions to identify if they are familiar with these contextual settings. She asks learners after reading the question aloud, “And what information have they given us already?” to ascertain if they have grasped the context rather than the mathematical requirements of the question.

12.3.5 The complex language used in examination tasks increases their difficulty

Participants complained about the language used by the DBE examiners in ML. Sarah indicated that the wording in the examination is complex. Vale (2018) identified in her research that nearly 20% of mistakes made in the ML examinations by learners were attributable to language related issues. Sindisiwe believes that all learners, whether English first or second language speakers, struggle to determine the mathematical demands of the ML examination questions given the language complexity. Yet she believes that because her learners are all English as second language speakers, they struggle to read the questions in English, and this makes it even more challenging for them to determine the mathematical demands. Nothando also noted that learners struggle because the ML examination questions are overloaded with complex language. She also indicated that many of these questions require learners to give their opinions in written responses that require a high-level understanding of English to do so.

Participants were asked if they felt that all stakeholders would benefit if ML examinations were to be translated into all the official languages in South Africa. Njabulo indicated that the translation of such contextual settings and terminology in examination questions would be challenging. Sindisiwe went further in indicating that it would be impossible to translate the examination papers in ML given the contextual settings and terminology.

For Njabulo, there is too much reading for learners in the examinations. If the instructions are not clear to them, they struggle to work out how to solve the mathematical demands. Learners are often unable to identify the mathematical demands in the questions set for examination by the DBE.

Bansilal and Khan (2013) explored this phenomenon in the Grade 9 mathematics CTA implementation and discovered that many learners did not complete the questions in the CTA because of their failure to understand the instructions in them. Jan also indicated this along with the complaint that there is too much reading for learners in a ML examination. The language used in the ML examinations is too complex according to Sarah. She indicated that learners also struggle to identify the mathematical demands in ML examinations because of the complexity of the language used. Vale et al. (2012) stated further that this necessitates further processing for learners, it saturates their working memory, and it prevents learners from engaging optimally in problem solving. Njabulo indicated that given all the aforementioned challenges, second language learners struggle a great deal with the instructions in the examinations.

12.3.6 Teachers feel that learners experience problems in identifying mathematical demand and linking this to the contextual setting.

Sindisiwe identified that learners struggle to extract mathematical demands from the contextual setting because they lack reading skills. Bohlmann and Pretorius (2008) suggested that mathematics learning is negatively affected if learners lack adequate reading skills. As Bridgette indicated, this limits their understanding and comprehension of the questions in ML. Jan indicated that the focus point for him is the reading of the questions to identify the contextual setting. Sindisiwe supports Jan's statement by also indicating that learners must read with understanding. She said she told her learners that "if you do not understand, you must maybe read three times, so that you can be able to analyse the statements, in order for you to answer the questions." Jan further elaborated that learners need to read the question and its contextual demands several times to identify the mathematical demands of the question. He also noted that attention needs to be given to the task information at the start of the question since this is where information that is required for the question is placed. Bridgette indicated that when contextual settings are added to ML questions, they become too complex for most learners to solve. Bridgette added that when higher level questioning in ML is

presented to learners, they struggle more to determine the mathematical demand of such questions. Njabulo identified that learners struggle with distinguishing between terms that have a mathematical meaning and a real-life meaning. The example he used was determining between the word “difference” used in a sum and “difference” used to indicate dissimilarity in a real-life context.

12.4 Research question two

How do teachers support the learners in addressing the language demands and complexity in ML?

In trying to provide answers to this research question, I draw on the questionnaire responses, lesson observations, and in-depth interviews. The analysis identified that teachers had various strategies that they used to help their learners deal with the language complexities in ML. There were some strategies that were common across all the participants, while some were shared by a few teachers. These included the identification of key words, teachers reading ML questions aloud, careful consideration in selecting resources, teachers’ disposition, linking contextual settings to find the mathematical demand in questions, and the use of code switching.

12.4.1 The teachers helped learners identify key words needed to understand the question.

One strategy used by teachers was helping their learners to identify key words in ML tasks. From the questionnaire responses, Table 5.6 in chapter 5 indicates that 64% of teachers acknowledged that when they use English as the medium of instruction learners struggle to understand them. Thus, intervention strategies need to be implemented accordingly. Bolstad (2020) determined that teaching ML effectively requires an integrated approach in which teachers implement minor changes in their teaching to improve the learners’ experience of learning. Participant V acknowledged this in suggesting that this can be done “by making them . . . read and underline the key words, [and by] unpacking the problems within the scenario.” The narrative chapters also provided more details about how this strategy was used. Sindisiwe used the same strategy as suggested by Participant V when she advised her learners to highlight key words in a question. She was observed identifying the key words for a question and instructing the learners to highlight them (see Figure 11.10). As Sindisiwe read every question, she identified the key words and defined them. As she explained, she repeated the definitions, and the learners repeated the definitions together with her.

Njabulo identified and wrote the key words on the board at the beginning of the lesson as learners walked into the classroom and he referred to these key words throughout the lesson. Njabulo indicated that he reviewed key words often with learners to have them familiarise themselves with

them. I observed Njabulo using a strategy of enticing learners to explore a question and tell him what they thought the key words were to gain a better understanding of the contextual setting. Bridgette explained that in using English as a medium of instruction she identifies key complex words and expands her explanation of them to support learners' understanding. I observed Bridgette asking learners to identify and name the key words in a question to determine the mathematical demands in it (see Figure 9.5). Jan accommodated learners by focusing on identifying key words that were part of the contextual language. He indicated that because of the use of high functioning English in ML questions, he believes it is vital for learners to identify the key words. Jan explained that if learners struggle to understand a question, he supports them by simplifying the question to identify its mathematical demand. He said that he supports learners in identifying three to four key words in a question to help identify this. I observed this in Jan's lesson when he interacted with the class to help them find the correct data in the contextual setting by identifying the key words in the question as "the annexure" and finding the missing "value A" (see Figure 6.8). Sarah placed emphasis on crucial key words and information given in questions from past examination papers. She also asked her learners to highlight the important information and key words in the task information section of the question while reading the rest of the question (see Figure 8.2).

Njabulo used code switching to establish a link between key words written on the board in English and elaborated on in spoken isiZulu. Sindisiwe used code switching to create an association between English key words in ML and an isiZulu description. Nothando supported learners by explaining key words and their definitions in English and explaining the methodology in IsiZulu to emphasise these. She referred back to the key words as she went on to explain the questions. Nothando indicated that the amount of code switching she used to support learners in identifying key words in ML questions was dependent on the level of English comprehension possessed by them. Ahn et al. (2020) stated that the effective use of code switching relies on a balance between it and the learners' ability in the official medium of instruction. Nothando's approach to learners gaining a better understanding of the mathematical demands in ML questions is to combine code switching and the identification of the key words in them. She generates a probing discussion with learners in order to determine their understanding of the mathematical demands by saying "But I need to know why?" to determine if learners have understood how to identify the key words.

Pillay and Bansilal (2019) identified that the contextual language—the words or phrases that hold a particular meaning in the context used in the task—poses particular difficulties for ML learners. The strategy of helping learners identify and unpack the meaning of the key words is used by teachers to try to minimise the difficulties of the learners in relation to the context-specific language. One aspect of these difficulties relates to the notion of contextual signifiers or objects or concepts that

convey specific information, and that have a meaning that is bound by the parameters of the context (Pillay & Bansilal, 2019). The lesson observations revealed some contextual signifiers that the teachers recognized as potential hurdles and that they targeted in their explanations. Nothando homed in on the contextual signifiers of multiple bar graphs and stacked bar graphs that were crucial if learners were to understand the questions (see Figure 7.5). In his lesson, Jan focused on a contextual signifier about the number (in thousands) of livestock (see Figure 6.2). He pointed out that if learners missed the information provided in the introduction to the task, they may not have realised that the numbers appearing in the table represented the number of thousands of livestock. Njabulo tried to break down the contextual signifier of the cumulative number of deaths per age group that were represented in a double bar graph. He elaborated in IsiZulu to make the learners understand the contextual signifier so that they could identify the third highest value in a graph.

12.4.2 Reading Mathematical Literacy questions aloud to support learners

All the observed teachers, except for one, read ML questions aloud in class. Bridgette, being the only participant who did not read aloud in class indicated that she makes her learners read the questions aloud to improve their literacy skills. Moussa and Koester (2018) indicated that teachers encourage better mathematical reading comprehension by asking learners to read aloud and then create discussion about what has been read. I observed that after the question has been read aloud by a learner, Bridgette asked if the learners could identify what the mathematical demands of each question were and addressed all misconceptions that could have arisen from the question. Freitag (1997) stated that the teacher should address any misconceptions that might develop from reading a question and that this can be achieved only if the teacher actively engages the learners with what they have read. Following this, Jan addressed the complexities of teaching learners who spoke different languages by walking in between the learners when he read the questions out loud and when he was elaborating on them. Jan did this to gauge if learners were understanding the questions read to them and to support those he believed to be struggling with comprehension. Johnston (2016) stated that reading aloud to learners and promoting related discussion with them has been found to enhance learners' word knowledge.

Trofimovich et al. (2012) stated that a simple way of increasing learners' exposure to identifying demands in a question is for teachers to read aloud to them. Sarah, while reading the questions aloud to learners guided them explicitly to the intentions behind the questions. She placed emphasis on the crucial information given in the question necessary to complete it successfully. As every question is read out by Sindisiwe to her learners, she identifies the key words and explains them. Trofimovich

et al. (2012) noted that teachers reading questions out loud can highlight their demands by reading slowly and with appropriate emphasis. Sarah reads questions aloud so that she can focus on the contextual information and key words that learners can easily overlook since this task information is supplied at the beginning of the question. Altay et al. (2020) indicated that learners will make a connection between the context and their life experience and this can help them understand the question and how it is relevant to their lives.

Sindisiwe reads the questions aloud in class in English to the learners and notes that not all learners understand the question when she does so. She stated that after reading the question aloud in English she will repeat it in IsiZulu to clarify the concepts and terminology. Nothando also reads the questions aloud in English, and, after doing so, she translates them into IsiZulu and phrases them in a way that she feels will be more meaningful to her learners. Mpalami (2022) indicated that translating mathematical tasks is a complex activity and Parket al. (2022), in referring to code switching as a bilingual experience, stated that code switching creates the opportunity for learners to gain language proficiency and also improve their understanding of the context in questions. Njabulo reads the questions aloud in English and states that he adds in additional sentences in IsiZulu to make the contextual setting and the mathematical demand more evident to the learners.

12.4.3 Resources are carefully selected or designed by teachers to support learners in Mathematical Literacy examinations

One of the findings that emerged from my study concerned the use of resources in the classroom. My analysis revealed that teachers carefully selected or even designed their own resources so that they could better prepare their learners for the ML examinations. Participants said that they select resources to support learners with the long-term objective of having them successfully understand how to determine the mathematical demands of ML examination questions.

The narrative chapters also provided support for this view. Jan indicated that the key words connect concepts learned in the classroom to questions in ML. Jan selects past paper questions as tasks to complete in lessons and he collates these into a booklet. He also sets his own assessments for learners in Grade 12 according to the standards and style of the end of year examinations for them. Nothando, Sarah, and Sindisiwe indicated that they print past paper questions and hand them out to learners in every lesson. Sindisiwe further justified that she does so to help prepare learners for examinations and assessments in ML. These printouts consist of past paper questions based on the topic to be taught in that specific lesson. Sarah also indicated that she also uses DBE past paper questions to prepare learners for the examinations through revision.

12.4.4 The teachers' personal dispositions conveyed empathy towards the learners as they tried to support them in dealing with the language complexities in Mathematical Literacy.

Across all the classroom observations, the teachers displayed empathy towards their learners as they tried to navigate their way through the ML tasks. Each teacher has different personal strengths that they channelled into assisting their learners. As the study progressed, I found that their personal dispositions towards their learners became more evident, and I tried to describe the nature of the teachers' personal dispositions by coining individual names for each one that I felt captured the essence of their teaching.

I named Sarah the Leader because she is the Senior Deputy Headmistress at her school. She indicated that as part of their school leadership practice, they advocate for designing subject packages to suit learners' abilities. She further indicated that as a teacher, she and her fellow colleagues place emphasis on developing lessons plans that are directed according to learners' academic ability. Thus, as a school the directive issued to the teachers and staff is to use their expertise to develop a learning environment that is geared towards developing the best possible learning outcomes for their learners. This was clearly evident in Sarah's classroom management skills that kept learners engaged during the observed lesson.

Jan was named the Mentor because he is a rugby coach, a hostel boarder master, and a ML teacher. Academically, Jan indicated that he adapts the pace of his lessons, how he approaches a specific class, and configures the curriculum to consolidate learning in the classroom that promotes learners' learning at their own pace. Jan also indicated that he requested that all new Afrikaans learners who are admitted to the school be placed in his mathematics and ML classes because, as an Afrikaans home language speaker, he can support these learners as they navigate their way through the cultural and linguistic challenges that a school such as the one at which he teaches can present.

Bridgette was named the Kind One for teaching SEN learners in a very understanding, kind, and supportive manner. Since she teaches in an SEN school, she approaches her learners in a softly spoken way and always attempts to support them given their academic and physical needs. Being in an SEN school, learners can have consistent illness, so Bridgette created a WhatsApp group to send work home to absent learners and their parents. She takes photos of her work on the board that links the contextual settings in the textbook to the mathematical demands of the questions and send them to help these learners catch up at home.

Nothando was named the Code Switcher since she was the participant who used code switching most frequently. She indicated that she promotes the identification of mathematical demands in ML

questions by reading the questions out loud to learners rather than having them read the questions themselves. She supplements this by using isiZulu to help learners grasp the understanding of the questions in ML. Nothando adapts her code switching according to her learners' needs to support them at a pace that is comfortable for them.

Njabulo was named the Organiser since he is the Head of Department of mathematics at his school. Also, he arranged for me to observe his colleague, Nothando. He managed and organized his lessons very well by using learners to complete the corrections on the board in order to give him time to support others who were dealing with all forms of misconception and errors in their work. Njabulo organises the worksheets given to learners in the school, and he stated that he focuses on adapting the work set for them to complete to accommodate and support their struggle with the language used in ML questioning. He used code switching to support his learners in the classroom.

Sindisiwe was named the Rising Star since she was the least experienced and youngest participant who was observed and interviewed for this research study. She was very enthusiastic about teaching ML, and she enjoys doing so but is fully aware of the challenges. She acknowledged in the interview that the greatest challenge is the language barrier. The learners do not understand English, so she has to explain a great deal using English and elaborating in isiZulu. Sindisiwe encourages her learners to use reading materials to improve their English proficiency. She recommends that they watch the learning channel on television, read newspapers, and use technology to gather quality reading resources to help improve their English reading skills.

Participants indicated that they adapt their teaching approach to accommodate learners in the teaching and learning of ML since they are aware the role language plays in effective learning in ML.

12.4.5 Participants' strategies in linking the contextual setting to find the mathematical demand of the question

It is evident from the data that the learners often struggled to make links between the contextual setting and the mathematical demands of the ML questions. The teachers were well aware of this struggle and tried to address it using their own strategies. In the questionnaire responses, Participant F indicated that "ML content and context needs to be taught together; we cannot separate the content from the context." Participant X emphasised that there is a need for strategies to link the contextual setting to finding the mathematical demand of a question and said that "the only problem

we have is that the context differs because a learner from urban and rural areas . . . don't interpret problems in the same way."

The narrative chapters also provided support for this view. Bridgette indicated that she first got her learners to identify the mathematical demand in the contextual setting and only then did she focus on methodology. Sarah identified that as a teacher she needs to elaborate on and identify the link between contextual setting and mathematical demand for her learners. (Reinke (2020) termed this contextual leverage.) Nothando further explained that she always introduces and elaborates on the contextual setting of the question before identifying its mathematical demands. Jan and Nothando indicated that they support learners in determining the key words in the contextual setting to determine the mathematical requirements or demands of the question. They then decipher the key words in a question to support learners to determine its mathematical demands. Bansilal (2014b) referred to the key words in a question as contextual signifiers. Jan and Nothando emphasised these contextual signifiers throughout their process of working on a question.

Participants indicated that they implement certain support strategies with the intention of improving learners' understanding of how to link the contextual setting to the mathematical demand of a question. Jan spends extra time exposing the contextual setting of a question. He focuses on how to read and understand it. Njabulo indicated that he gives learners ample time to complete work to allow them to read the questions and familiarise themselves with the contextual settings before they identify the mathematical demands of the questions. I observed that Sindisiwe and Bridgette posed possible questions that could evolve from the contextual setting to give the learners the opportunity to gain familiarity with them. Sarah selects questions in which she believes the contextual setting is familiar to the learners to promote the identification of the linked mathematical demands. Bansilal and Debba (2012) noted that engagement with the context is hampered when learners do not understand the rules or language of the context. Sarah motivated that as learners move from Core mathematics they need to acclimatise themselves into the kind of questioning that is based on contextual settings. Sarah also indicated that when a contextual setting is addressed in a lesson, she adds additional questions to help expand learners' understanding of this. Njabulo stated that he believes that because his learners are all second language English speakers, they struggle with the contextual setting, so he reviews the key words with them to help them deal with their difficulties. Bridgette supported Njabulo's approach by adding that she makes a glossary for learners to use to connect key words to the contextual settings given in questions.

12.4.6 Code switching to support the understanding of the contextual setting to find the mathematical demand of the question

From the questionnaire responses, I saw that participants motivated their use of code switching. Participant Q stated, “I code switch to make them understand.” Participant V further elaborated, “Code switching helps learners understand better when [I am] teaching ML.” Participant O justified the use of code switching by stating. “I use code switching. Yes, I totally agree with the use of English as a medium of instruction, but in the correct situation it’s hard.”

The narrative chapters also provided support for this view. Four of the six participants who were interviewed disclosed that they use code switching as a strategy to support learners in gaining more familiarity and understanding of the contextual setting in ML questions, thus supporting them in determining the mathematical demands that arise from the contextual setting. Moschkovich (2007) stated that the objective of code switching is to create a hybrid language practice that achieves fluency in two languages. Each of the participants used code switching to support their learners to gain a better understanding of the contextual setting to identify the mathematical demands in ML questions. However, each of the four participants displayed varying uses of code switching during their observed lessons. The amount of code switching used by a teacher is influenced by the time, place, audience, and intended communicative purpose to promote teaching and learning in the classroom (Lee, 2017).

I also noted in the lesson observations that all four participants wrote on the board in English only. The participants did so to create a connection between the local language used in the classroom and the written words in English on the board. Njabulo elaborated on this matter by indicating that all his learners want to create a connection between the key word in English that is written on the board and its spoken local (in this case, isiZulu) equivalent. Sindisiwe indicated that the intention is to create an association between the key word and the description. Boateng (2019) explained that teachers must exploit learners’ home language in order to increase their understanding of English. Academic or key terms must be taught in both the learners’ home language and English to develop the cognitive skills required. They suggested that code-switching does not necessarily mean that these languages are distinct and separate in teaching and learning, but, rather, that the objective of code switching is to have two languages intertwined. Njabulo and Sindiswe use code switching to mediate, in isiZulu, the meaning of the key words written in English.

Njabulo indicated that he code switches to address complexities that arise from contextual settings in ML questions. He said that if he does so, the mathematical demands of the questions become obvious and more evident to learners. He did indicate, however, that he always attempts to use

English as the medium of instruction since it is the language used in the final examinations and the learners need to be familiar with the terminology in English. For him using too much isiZulu in code switching would disadvantage learners and they would struggle to identify or understand the ML terminology in English. For McCabe (2013), teachers' use of code switching can prevent "poor educational achievement [and can lower] the barrier that English as incomprehensible language erects, especially at the lower levels" (p. 176). However, she also noted that an overemphasis on English will produce English literate learners who will fall far behind in content learning and will fall behind academically.

I noted that Njabulo reads questions aloud in the class in English and adds additional sentences and information in IsiZulu to elaborate on and explain the contextual setting further in a language that is more understandable to the learners so that they can identify the mathematical demand in ML questions.

Sindisiwe stated that because many languages are spoken in her classroom, she selects the language that is understood by most of the learners in the class and uses code switching where relevant to increase their understanding of the contextual setting in ML questions. She also noted that learners struggle with the mathematical language used in ML questions. She used the example of learners not knowing that the term purchase is synonymous with buy and explained this to her learners. She used the isiZulu word *umthenga* which means to buy something to create an association with the word purchase. McCabe (2013) addressed the need to use code switching because at times the nuances of meaning in specific words cannot always be translated into a single word.

I observed Nothando using code switching to simplify the wording of the questions to make the contextual setting more intelligible to her learners. For her, learners will recognize similar contextual settings more easily and thus will be able to identify the mathematical demands inherent in these contextual settings more effectively. Nothando also indicated that she is selective in how she uses code switching. She indicated that when she is introducing a topic in ML she uses more isiZulu to enable learners to gain a better understanding of the contextual settings in the ML questions. When learners gain a better understanding of the topic and its contextual settings, she uses more English to discuss the mathematical demands of the ML questions, and this helps consolidate learning. Nothando summarised this in saying that she needs "to build them up to . . . English." For McCabe (2013) scaffolded code switching aids understanding in the classroom and improves teacher-learner rapport in that teachers can start with using with minimal English when code switching and, as time progresses, can use less vernacular language and more English.

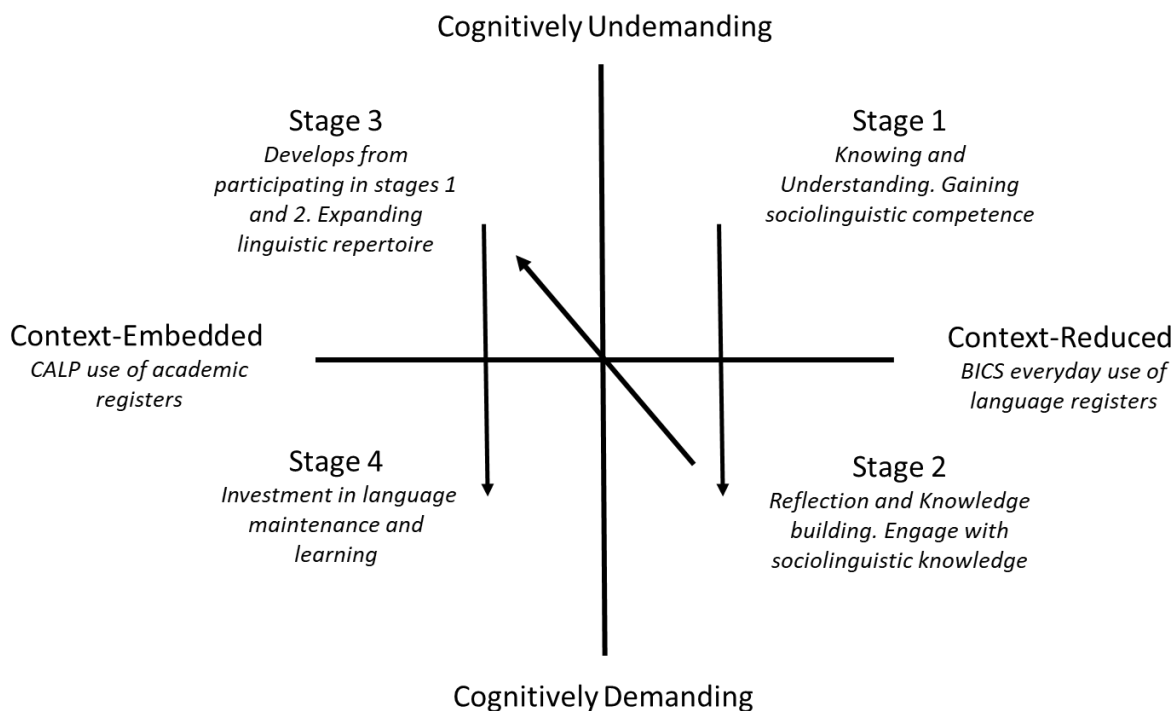
Sarah indicated that she speaks isiZulu in class to reprimand learners. I observed that she supported learners on a one-to-one basis by code switching to explain the contextual challenges in the ML questions and to help them identify the mathematical demands.

12.4.7 Findings derived from the 4QCCDF

The context of this study was to evaluate teachers' responses, by using the 4QCCDF, to the language demands associated with the learning of ML. Cummins (1979, 1984, 1991) designed and developed a four-stage learning sequence model of language acquisition that I have adapted to display the connection between mathematics as a subject and language acquisition and, thus, to indicate mathematical achievement (see Figure 12.1). The four stages of language acquisition are learning in a context reduced, cognitively undemanding environment, followed by a context reduced, cognitively demanding environment, then moving to a context embedded, cognitively

Figure 12.1

Cummins's (1994) Four-Quadrant Contextual and Cognitive Demands Model (p. 41, adapted).



undemanding environment, and, finally, in a context embedded, cognitively demanding environment. Cummins (1981, 1994) proposed a four-quadrant framework (see Figure 3.1) in which each quadrant is formed by the intersection of two axes. Additionally, to the stages of acquiring language acquisition, BICS and CALP were added to display the distinction between each different use of language in the process of acquiring adequate language development in mathematics. ML presents barriers to learning in its formulation of questions. Participants indicated that learners struggle to identify the mathematical demands in ML questions because of their complex wording and foreign contextual settings, and because the terminology specific to ML presents as a new register. It is argued that to meet the language demands of ML tasks and assessments involves having learners acquire CALP in ML. Although it can be argued that ML uses BICS in its assessments and tasks, the integration of BICS into local contextual and foreign contextual settings and lexically dense questions that can be overloaded with information, presents a barrier to learning. Given the aforementioned challenges in ML assessments and tasks, the learners' language of BICS are inadequate, and they have to acquire the language of CALP if they are to manage ML assessments and tasks successfully.

All this places emphasis on the range of cognitive demands and contextual support involved in language-based tasks and activities for learners in ML classrooms. All these components were added into the four-quadrant framework that was named the 4QCCDF. At the first stage, learning takes place in the context of BICS where contextual settings are reduced, and tasks are cognitively undemanding. This stage is placed in Quadrant C in the four-quadrant framework. In the second stage of using BICS, tasks are cognitively demanding but their contextual settings are still reduced. This stage is placed in Quadrant D in the four-quadrant framework. In the following step learning takes place in the context of CALP tasks that are cognitively undemanding, and the contextual setting is embedded in the tasks. This stage is placed in Quadrant A in the four-quadrant framework. In the last stage at which learning takes place in the context of CALP, tasks are cognitively demanding, and the contextual setting is embedded in the tasks. This stage is placed in Quadrant B of the four-quadrant framework.

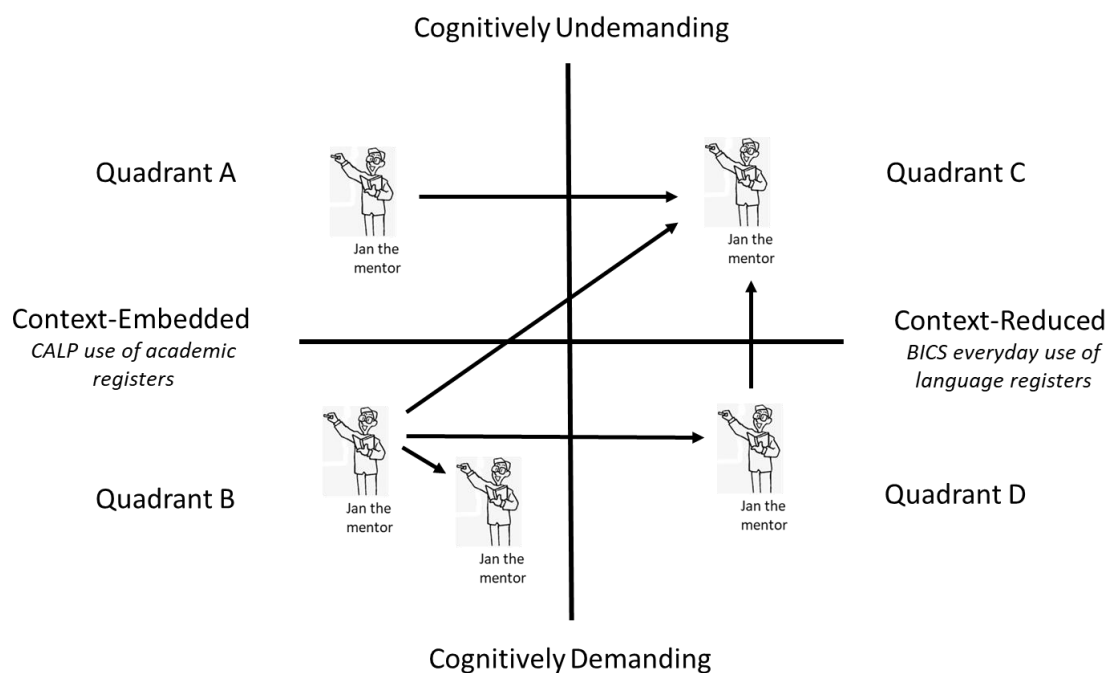
The 4QCCDF was designed to place the findings of this study in relation to each participant to determine how they perceived and responded to the language demands made of learners in the ML classroom. CALP was the lens through which the relationship between ML specific terminology and ML contextual settings related to participants' teaching of the ML curriculum was scrutinised. Cummins's four-quadrant model envisages that optimal language acquisition takes place when learners are placed in a learning environment in which tasks are context embedded and cognitively demanding. In other words, CALP is necessary for learners to engage and participate in the

classroom setting. Nyoni (2021) supported this statement by indicating that learning and teaching activities in the classroom should create opportunities for the development of CALP. However, Andorno and Sordella (2021) stated that for learners to build CALP capacity in the Language of Learning and Teaching, content taught in the classroom needs to be negotiated and adapted to the cognitive and linguistic levels of CALP. However, it was observed that the limitation in learners' CALP constrained their thinking and limited conversational opportunities in the ML classroom. This also constrained the written work produced by learners (see Olvera and Gomez-Cerrillo, 2011).

The intentions of participants regarding the difficulty of the tasks and assessment questions presented to learners was observed and depicted (see Figure 12. 2). These tasks were chosen by participants according to their appropriateness since they taught classes in Grade 10 to Grade 12. I offer a description of how participants moved from quadrant to quadrant in their teaching process in the classroom (see Figures 12.3 to 12.8). Thus, the illustration of their shifts from quadrant to quadrant of the 4QCCDF describe and capture how teachers used their tasks and questions in the ML classroom to support their learners. The participants adapted illustrations and descriptions of the tasks or questions to what they believed to be the optimal environment in which learners could

Figure 12.2

4QCCDF illustrating Jan's movement between quadrants.

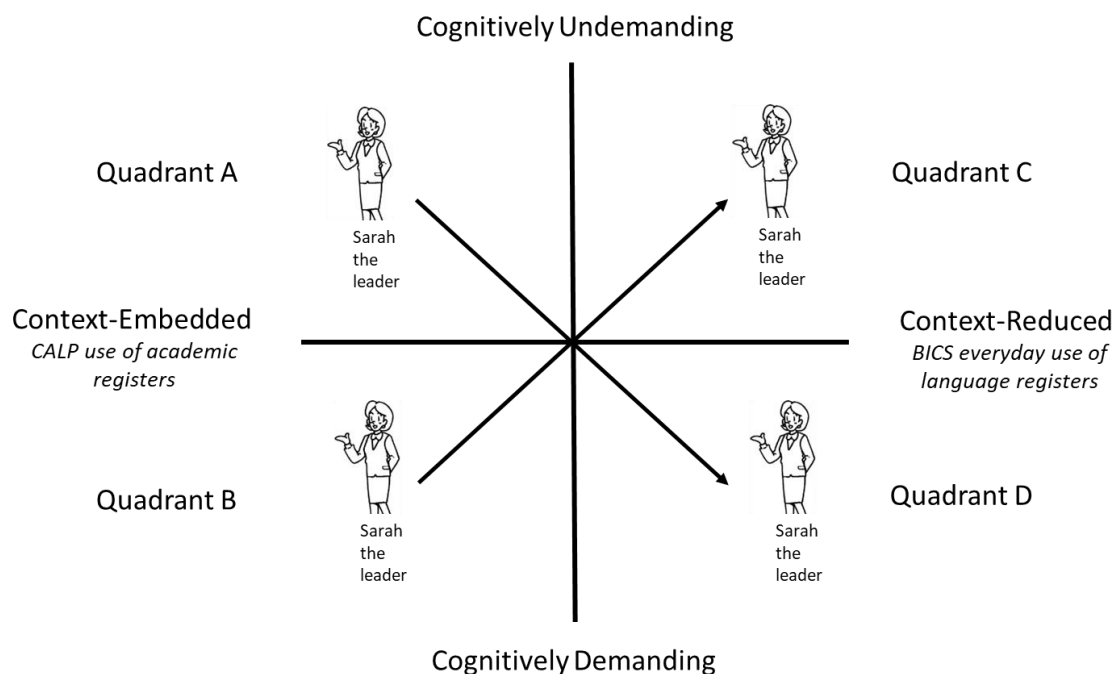


understand and engage with these tasks as learning resources. I have illustrated this approach by the participants by displaying their interventions as moving from quadrant to quadrant in the 4QCCDF.

I illustrate my findings related to each teacher participant by using the 4QCCDF. It needs to be noted that in a very few instances participants supported learners by either remaining in the same quadrant as Sindisiwe did by using the same contextual setting and changing the signifier to give learners the opportunity to experience different contextual signifiers with the same contextual setting. Bridgette was observed changing from Quadrant D to Quadrant A by introducing a contextual setting to a question that did not have one. Njabulo stayed in the same quadrant by giving learners a question in which he both changed the contextual setting and retained it so that his learners could be given the opportunity to witness the use of the mathematical rule in another setting to gain a better understanding of it. Jan stayed in the same quadrant when he simplified the calculations of the mathematical demand in a contextual setting that he considered would give learners the opportunity to understand the mathematical demand.

Figure 12.3

4QCCDF illustrating Sarah's movement between quadrants.



A distinct pattern that was extrapolated from the findings is that all participants deemed it necessary to support their learners by clearing the task of its contextual setting and unpacking the mathematical demand into manageable step-by-step procedural calculations. All that learners needed to do was follow these steps to arrive at the correct answer. The optimal level of learning in the ML classroom is envisaged to take place in Quadrant B. However, adapting Cummins's model to the setting in which ML teaching and learning was taking place as the sole purpose instead of learners being in a language-learning-based classroom, the goals of the participant teachers seemed to be different. They displayed the urgency of the need for learners to achieve in the examinations and to perform well in the completion of tasks set in the classroom. Their objective was to give learners questions that would facilitate teaching and learning in Quadrants A and B. However, participants removed the contextual settings and complexities that these tasks presented and simplified the mathematical demands, thus removing the contextual setting from the mathematical demands and thus evading Cummins's objective that learning should take place in Quadrant B and continually promoting learning to take place in Quadrants C and D. Thus, a counter movement in the quadrants took place; participants moved from Quadrant B to C (see Figure 12.2) because they believed that this would be the best way of teaching their learners ML.

Jan and Sarah were observed teaching Grade 12 learners and preparing them for their NSC Examinations. Jan gave learners past paper examination questions that were placed in Quadrants A and B of the 4QCCDF, as questions are in the examinations (see Figure 12.3). Excluding the one exception where Jan remained in Quadrant B, he posed questions to the learners in Quadrant B and A and supported them by removing the contextual settings. Jan then had learners either solve these problems by leaving them to solve multi-step questions in Quadrant D or he supported learners by solving the mathematical demands of a question placed in Quadrant C on a step-by-step basis.

Sarah also gave learners past paper examination questions that were placed in Quadrants A and B of the 4QCCDF to prepare them for the examinations (see Figure 12.4).

Sarah was observed giving learners questions categorised as belonging to Quadrant A, supporting them by removing the contextual settings of the questions, identifying the mathematical demands, and having learners solve multi-step questions, thus moving the calculations into Quadrant D. Sarah also gave learners questions that were placed in Quadrant B, removed the contextual settings, and supported them in identifying the mathematical demands of these questions. She broke the mathematical demands down into manageable one-step calculations that displayed how she moved from Quadrant B to C.

Figure 12.4

4QCCDF illustrating Bridgette's movement between quadrants.

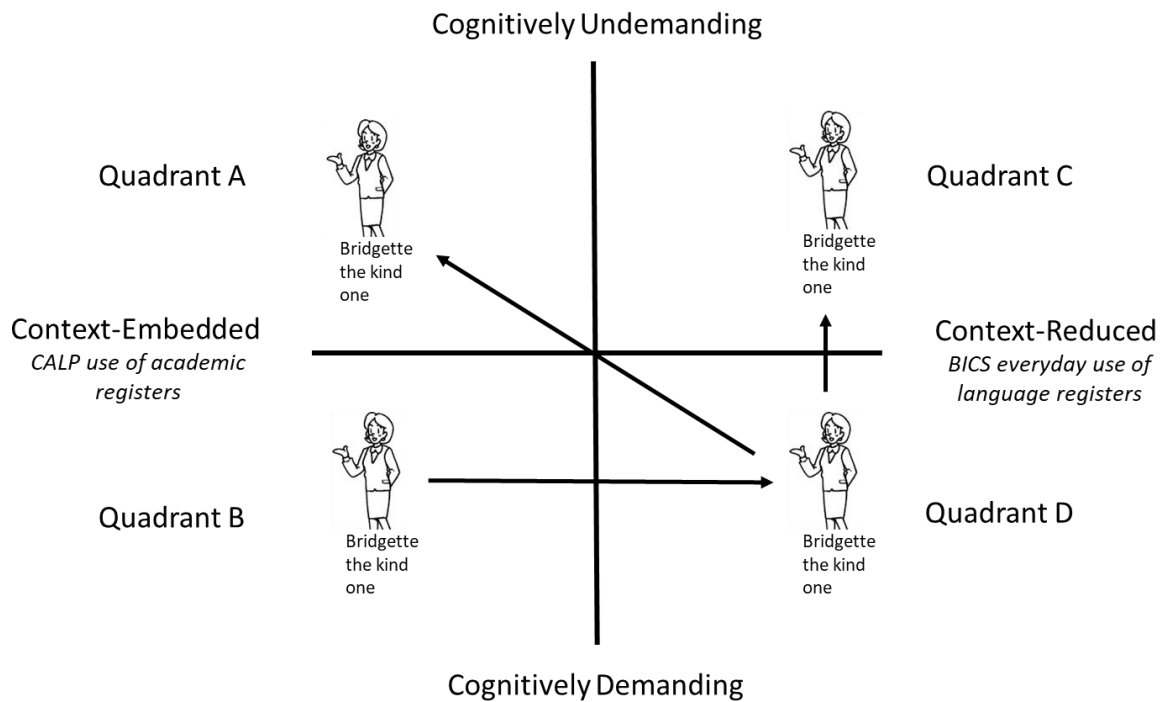
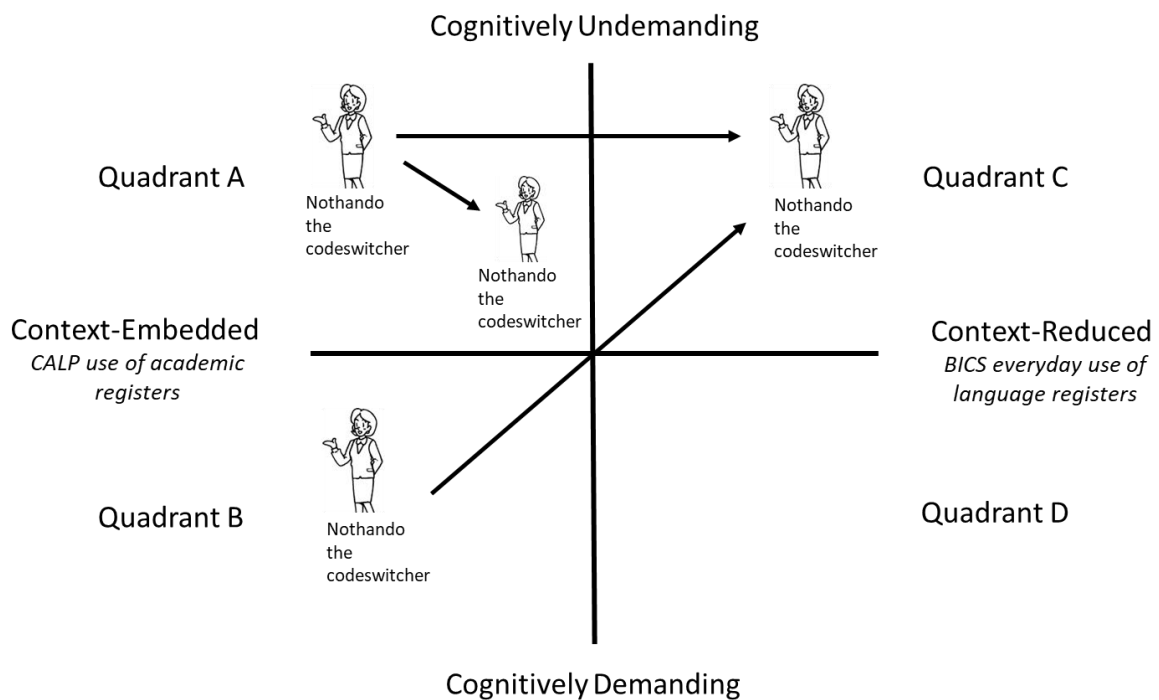


Figure 12.5

4QCCDF illustrating Nothando's movement between quadrants.

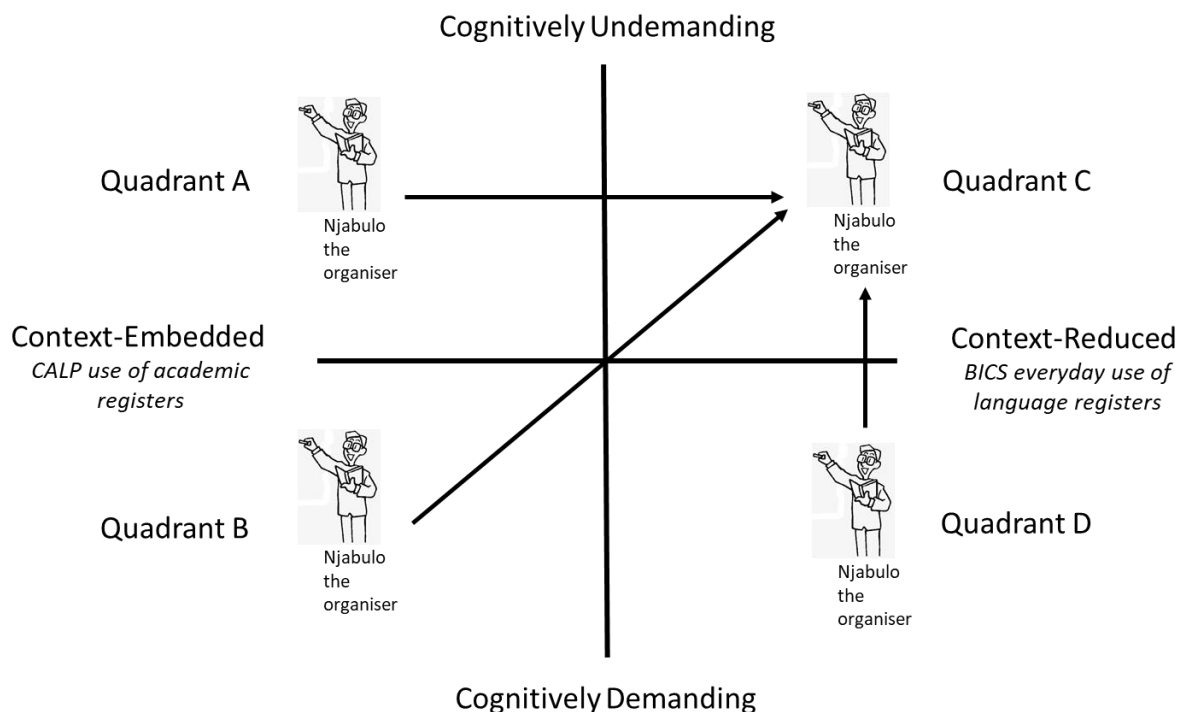


Bridgette was observed teaching a Grade 11 class. Tasks were set using a textbook (see Figure 12.5). Excluding the one exception where she moved from Quadrant D to Quadrant A by introducing a contextual setting as an example to give a mathematical demand a realistic context, she posed questions to the learners in Quadrant B and Quadrant D. By supporting them in her removing the contextual settings of Quadrant B categorised questions she placed them in Quadrant D. She supported learners by breaking the multi-step questioning up into manageable single-step calculations so that they could derive the answers, thus moving to Quadrant C.

Nothando, Njabulo, and Sindisiwe were observed teaching Grade 10 learners. They all used examination style questions. Excluding the exception where Nothando remained in Quadrant A by changing the contextual setting, still using the same mathematical concepts to further learners' understanding of the concept, she gave learners questions categorised as Quadrant B and A questions in the 4QCCDF (see Figure 12.6). She removed the contextual settings of the questions in Quadrant B, identified the mathematical demands, and broke up the multi-step question into

Figure 12.6

4QCCDF illustrating Njabulo's movement between quadrants.

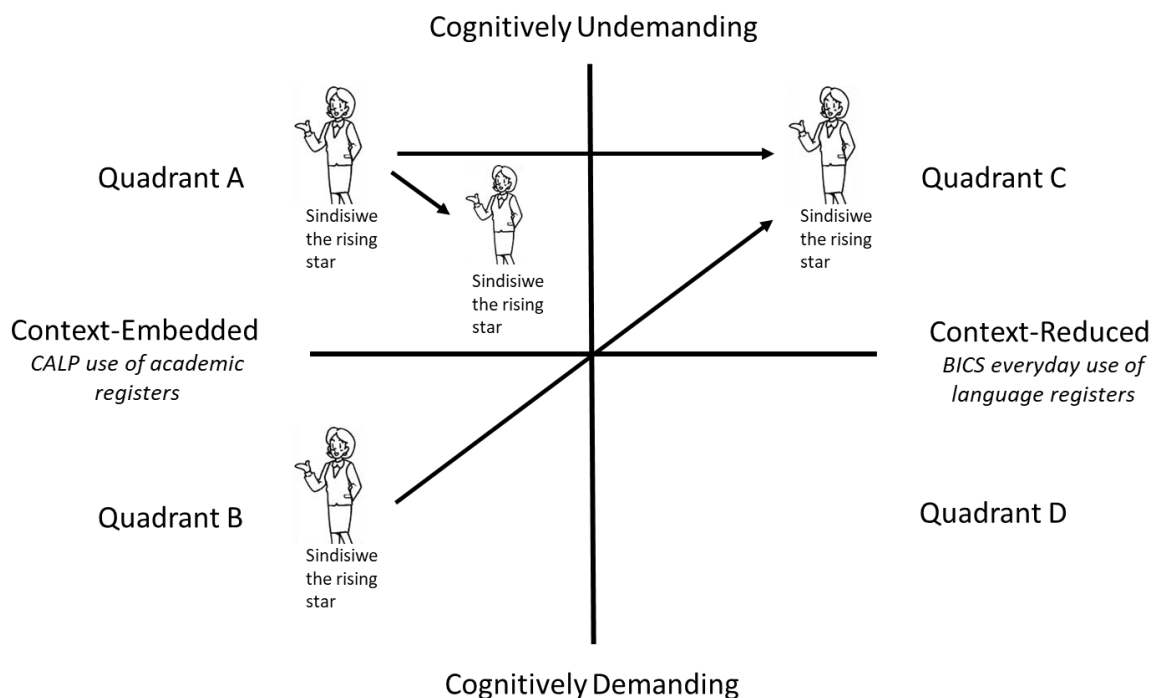


manageable one-step calculations to derive the answer. Nothando also removed the contextual setting from questions categorised as belong in Quadrant A and supported learners by extracting the answer from the mathematical demand or supported them in one-step problem solving to derive the correct answer.

Njabulo also used examination style questions. He gave learners in his observed lessons different questions that ranged from Quadrant D to A and B (see Figure 12.7). For Quadrant D questions, he supported learners by breaking up multi-step ones into manageable one-step calculations. For Quadrant A categorised questions, Njabulo removed the contextual setting from the question and supported learners by extracting the answer from the mathematical demand or he supported them in one-step problem solving to derive the correct answer. Njabulo also supported learners with questions categorised as Quadrant B ones by removing the contextual setting and breaking up the multi-step questions to help them to derive the answer by having them solve one-step questions.

Figure 12.7

4QCCDF illustrating Sindisiwe's movement between quadrants.



In the observed lesson, Sindisiwe selected past examination paper questions that addressed the topic taught. Excluding the exception where she remained in Quadrant A by using an alternative task in the same contextual setting to support learners in understanding the contextual language used in the question, she gave learners questions categorised as Quadrant B and A questions (see Figure 12.8). Sindisiwe removed the contextual settings of the questions categorised as Quadrant B, identified the mathematical demands, and broke up the multi-step questioning into manageable one-step calculations to derive the answer. Sindisiwe also removed the contextual setting from Quadrant A questions and supported learners by extracting the answer from the mathematical demand and helped them derive the correct answer in one-step problem solving.

12.5 Research question three

What are teachers' suggestions on how they could be more effectively supported in teaching ML?

During the in-depth interviews, all participants, in unprovoked comments, voiced their opinions and concerns regarding the role the DBE plays in learners' learning ML and how the DBE could support them. The participants' responses in the in-depth interviews motivated me to add in an additional research question based on determining the perspectives of teachers on the role the DBE plays in supporting them to help learners perform optimally in ML. Two highly relevant points arose from these interviews.

12.5.1 The Department of Basic Education must ensure greater alignment between textbook and examinations.

Some participants indicated that there is no relationship between DBE ML textbooks and the examinations set by the DBE. Njabulo indicated that the textbooks and examinations are not at the same level. He elaborated further by indicating that the textbooks are not correctly aligned with examination questions. Bethell (2016) indicated that a textbook is effective in mathematics only if it undergoes rigorous evaluation in advance of publication. However, he said that in Sub-Saharan Africa there is little evidence that new textbooks are evaluated in relation to their effectiveness as an aid to learning. Njabulo expanded on this by saying that if you use only the textbooks and the examples in the textbooks, learners will not perform well in the examinations. Sindisiwe, Sarah, and Njabulo indicated that the DBE's ML textbooks are not adequate to prepare learners for the examinations. Sarah specified that none of the resources that the DBE releases for ML are sufficient to prepare learners for the examinations. Jan further indicated that there is a lack of consistency between ML textbooks and examinations and that this makes examination preparation for learners

unpredictable and difficult. Sindisiwe supported Jan's statement and said that the contextual differences in the textbooks and examinations make preparation for examinations difficult for teachers and learners. Njabulo said that you have to use past examination paper questions to prepare learners for the style of examination questions used since the textbooks will not prepare them for the examinations.

12.5.2 The Department of Basic Education must create channels of communication between and among teachers, Department of Basic Education, and examiners.

Participants displayed displeasure as they indicated that they do not know how to communicate important information about ML to stakeholders in the DBE. Jan indicated that there are no communication channels through which one could complain or advise the DBE. Jan feels that the DBE does not take teachers' input seriously. He also indicated that there is no communication between examiners and what happens in the classroom. The examiners do not understand the complexities of teaching ML and thus the examinations do not reflect teachers' input. Bridgette indicated that because there is no communication between herself and the DBE, she cannot inform the DBE that there is a lack of examination materials for visually impaired learners and thus no adequate preparation can take place. The teachers would welcome the establishment of some sort of forum in which they can present their feedback to the DBE about the examinations papers and about the policies governing the teaching of ML.

12.6 Reflection

As an observer of teachers teaching ML lessons, I tried to cause as little disruption in their classrooms as possible. This meant that I was not able to observe the discussions the participant teachers had with individual learners in the classroom. I travelled four times from the United Kingdom to Kwa-Zulu-Natal to conduct the data collection process over nine months and was aware that the limited time I spent in Kwazulu-Natal may have been inadequate to fully accommodate my participants in this data collection process.

12.7 Recommendations and opportunities for further research

This research study raised some pertinent issues in relation to further investigative research.

- Participants felt disempowered as far as influencing the outcomes in ML is concerned and thus have no chance of improving the ML curriculum. It is evident that these teachers and,

of course, the many whom I did not observe, have the expertise and knowledge to advise the DBE on how to improve the teaching and learning environment in a ML classroom.

Research on the existing channels of communication between stakeholders of the DBE and the ML teachers needs to be conducted in order to develop mutual and respected communication between all stakeholders involved in ML.

- The findings also indicate that further research needs to be conducted on the quality of the ML examination papers released by the DBE. Participants noted that the examination papers released by the DBE are inadequate in respect of mathematical accuracy and have many grammatical errors. Research on how this can be improved needs to be conducted. Teachers' input into this matter in relation to their personally designed materials could be an invaluable resource.
- Further research needs to be conducted on how the DBE views the language demands associated with the learning of ML as reflected in the DBE policy documents on ML. A review of ML subject policy documentation needs to be undertaken to improve the outcomes and thus improve the teaching and learning of ML.
- Further research needs to be conducted on the effect the DBE resources have on in teaching and learning in ML classrooms. Participants recommended that improved communication and consultation between themselves and relevant stakeholders in the DBE could lead to the creation of quality resources and grammatically correct examination papers that could be supplied to teachers. This would give ML teachers the opportunity to make the notion of contextual settings familiar to learners by using resources that include examinable contexts along with relevant ML terminology.
- It is recommended that further longitudinal studies be conducted in this research field and on focussing on learners' views of the research topic.

12.8 Limitations of the study

This research study is not free from limitations. The data collection could have benefitted from an ethnographic observational approach. This would have given rise to more authentic evidence being collected during the lesson observations. The generalisability of the results is limited to the teachers who participated in the research study. These participants' schools were all located in the Umlazi and Pinetown Districts of Kwa-Zulu Natal. Those participants who spoke English as a second language may not have fully understood the questions I posed to them during their interviews and

this may have affected their responses to some of them. Furthermore, having to express their responses in English could have meant that they were unable to meaningfully express what they really wanted to say. Lastly, I conducted the research study with participants working in quintile 3 to 5 schools, with one being a SEN school. The study could have benefited from my including data from quintile 1 and 2 schools.

12.9 Contribution of this study

This study emphasises that there is a need for intervention in the DBE's ML policy given that ML teachers concerned about the influence that English language proficiency has on a learner's ability to perform optimally in ML. This study indicates the need to improve communication channels between ML teachers, ML examiners, and the DBE that will lead to the development of ML policies that will, in turn, promote improved teaching and learning across all ML classrooms in South Africa.

12.10 Final reflection

In this research study I see the challenges involved in ML's necessarily having both mathematical subject matter and contextual settings. This combination presents challenges to learners who struggle to understand the language used to convey the contextual settings of ML questions before they even come to understand the mathematical demands of the questions. All stakeholders in ML must understand this need to embrace both contextual settings and mathematical demands equally in the teaching and learning of ML. Thus, DBE ML curriculum documentation needs to reflect this if it is to acknowledge and address the challenges inherent in the teaching and learning of ML.

12.11 Conclusion

In this chapter I collated the data collected for this research study and used it to answer the three research questions. The data indicates that teachers had various perceptions of the learners' struggles with the language complexities in ML as explained in this chapter. I explained how teachers support the learners in addressing the language demands and complexities in ML and set out the participant teachers' suggestions on how they could be more effectively supported in teaching ML. I reflected briefly on the research study and acknowledged possible improvements. I offered recommendations and suggested further research possibilities. I identified the limitations of this study and the contributions this study has made to this particular field of research.

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Appendices

Appendix A

Questionnaire for teachers.

Dear Participant

Thank you in advance for your participation in this questionnaire. Please answer the questions about teaching Mathematical Literacy (ML) below as honestly as you can. The details that we ask for, will only be required for verification purposes and will not be disclosed in any of the research report. This questionnaire consists of five pages and six questions.

Name: Cell No.....

Email..... Name of school

1. Please tick or write a number in the relevant box

Gender /experience		Qualification	
M		3-yr diploma in mathematics	
F		PGCE	
		Bachelors' Degree	
Years of teaching experience		Higher than a bachelor's degree	
Years of teaching ML		Other: (Specify)	

2. Mathematics and Mathematical Literacy

2.1. In what ways do you think the purpose of mathematics and ML differ?

.....

.....

2.2. In what ways do you think mathematics and ML differs in general?

.....

.....

Using the following scale of 1-5, use a number to indicate the degree to which you agree with the statements listed below, where

1	2	3	4	5
Strongly disagree	disagree	Neutral	agree	Strongly agree

2.3. I am pleased with the pace of the ML curriculum 1 2 3 4 5

2.4. I am able to complete the curriculum each year 1 2 3 4 5

2.5. All the topics in the ML curriculum is necessary 1 2 3 4 5

2.6. The ML curriculum needs to include more topics, for example algebra & geometry
1 2 3 4 5

2.7. The ML curriculum is well suited to achieve the purpose of ML 1 2 3 4 5

2.8. The sequencing of the ML topics according to CAPS makes sense 1 2 3 4 5

2.9. I believe that mathematics learning helps learners to deal with real life problems
1 2 3 4 5

2.10. I believe that ML is necessary because it will help learners solve real life problems
1 2 3 4 5

2.11. In Mathematical Literacy, learners should first be taught mathematics content and then taught to deal with real-life contexts 1 2 3 4 5

2.12. A teacher needs a strong mathematical background for effective teaching of Mathematical Literacy 1 2 3 4 5

Any comment

.....

3. English proficiency and ML

Using the following scale of 1-5 to indicate the extent to which you agree with the statements that follow

1	2	3	4	5
Strongly disagree	disagree	Neutral	agree	Strongly agree

3.1. The home language of the majority of the learners in my school is English 1 2 3 4 5

Comment

.....

.....

3.2. I am very proficient in speaking English 1 2 3 4 5

Comment

.....

.....

3.3. Learners who do not speak English as a first language are disadvantaged in a Mathematical Literacy classroom 1 2 3 4 5

Comment

.....

.....

3.4. Learners who do not speak English as a first language struggle to answer test and examination questions because of the lack of their English language skills 1 2 3 4 5

Comment

.....

.....

3.5. A teacher needs to be very proficient in English for effective teaching of Mathematical Literacy 1 2 3 4 5

Comment

.....

.....

THANK YOU

Appendix B

Interview schedule

In-depth interviews

The data collected from the observations and assessment analysis will be the main bases of creating informative questioning. Questions below were baseline questions for each interview.

Baseline questions will be:

i) Background information about school, how it is to teach there and resources and teachers educational history.

1. Do you speak English as your home language?

2. Through you're

a) Teaching experience and

b) Your own schooling experience, how do you experience the wording (English) used in the Curriculum and in the Mathematical Literacy Final examinations?

3. Do you know how many languages are spoken in your class that was observed?

4. As a teacher:

(a) In what language do you teach Mathematical Literacy in your class?

(b) What are your views about the teaching of Mathematical Literacy in the language you use?

(c) What other languages do you think could be used in the teaching of Mathematical Literacy in your class?

(d) What do you think is the appropriate language for teaching Mathematical Literacy in your class?

Supporting questions:

- How do you think you can accommodate, if needed, to support learners in the classroom in relations to the language of mathematics. Do you need to change the way you teach?

a) How do you take into account learners struggling to understand the written work in Mathematical Literacy?

b) How do you support them in this struggle?

- c) Do you think that learners (second language) and learners (first language) English speakers both struggle with language in Mathematical Literacy?
- d) Are their struggles different? If so, explain with an example what you have experienced regarding this matter and how you dealt with it.
- e) Do you feel that learners (second language) battles with the complexities of Mathematical Literacy language?

Question 1

- Do you feel that Mathematical Literacy task language is too overloaded with complex language?
- Do you feel that the language you use influences learners learning?
- Do you feel that learners find Mathematical Literacy easy but when it is written in English on the blackboard, textbook or examination they find it more difficult?

Question 2

- How do you think language links to real-life Mathematical Literacy applications?

Question 3

- Do you feel that mathematics has its own language?
- How do you feel about the language used in Exams and in the curriculum?
- Do you feel that you need to teach learners more than just mathematics in a Mathematical Literacy lesson?
- How do you think you will be teaching Mathematical Literacy in 5 years' time? Do you believe you need to make a change your teaching strategies?

Appendix C

Permission to conduct research



KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE HEAD OF DEPARTMENT

Private Bag X9137, PIETERMARITZBURG, 3200
Anton Lembede Building, 247 Burger Street, Pietermaritzburg, 3201
Tel: 033 392 1063

Email: Phindile.duma@kzndoe.gov.za

Enquiries: Phindile Duma

Ref.: 2/4/8/7180

Mr Quintus Dawson
109 Cuckfield Road
Hurstpierpoint
West Sussex
UNITED KINGDOM
BN69rs

Dear Mr Dawson

PERMISSION TO CONDUCT RESEARCH IN THE KZN D&E INSTITUTIONS

Your application to conduct research entitled: **"AN EXPLORATION OF HOW TEACHERS TAKE ACCOUNT OF THE PERCEIVED RELATIONSHIP BETWEEN LEARNERS' ENGLISH PROFICIENCY AND MATHEMATICAL LITERACY PERFORMANCE"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from **29 October 2021 to 13 September 2023**.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.



Dr MJB Mthembu
Acting Head of Department: Education
Date: 29TH October 2021

GROWING KWAZULU-NATAL TOGETHER

Appendix D

Permission to conduct research



education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries:

Imibuzo: S Pillay

Navrae: 031 3606597

Reference: Research

Inkomba:

Verwysing:

Date:

Usuku: 2910/2021

Datum:

TO: The Circuit Manager

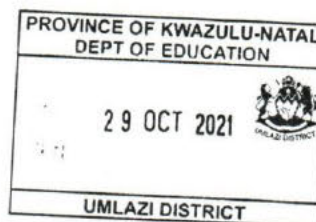
The School Principal

RE: PERMISSION TO DO RESEARCH WITHIN OUR SCHOOLS IN UMLAZI DISTRICT

1. The attached letter dated 29 October 2021 refers:
2. Attached is the permission letter approved by the HOD which permits Mr Quintus Dawson to do his research within your school in Umlazi District.
3. The researcher is however requested to abide by the required moral and ethical standards during their research period in your school. He is further requested to keep all information obtained confidential and reported only in terms of the code of practices of Higher Education Institutions practices and policies.
4. You are requested to assist the researcher to the best of your ability.
5. There will be no disruption of Teaching and Learning during interaction between the school and researcher.
6. The office of the District Director wishes the researcher the very best during their school visits in Umlazi District.

S Pillay

Office of the District Director: Umlazi



Championing Quality Education - Creating and Securing a Brighter Future

KWAZULU-NATAL DEPARTMENT OF EDUCATION

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Facebook: KZNDOE... **Twitter:** @DBE_KZN... **Instagram:** kzndoe... **Youtube:** kzndoe

Appendix E

Informed consent form principal

Informed Consent Document

Dear Principal,

My name Quintus Dawson (202512967). I am a PhD candidate studying at the University of Edgewood. The title of my research is: An exploration of how teachers take account of the perceived relationship between learners' English proficiency and Mathematical Literacy performance. The aim of the study is to determine the perceptions of teachers and grasping teachers understanding if language proficiency plays a significant and problematic role in Mathematical Literacy performance. I hereby request permission to use your school for my research study. I would like to invite a Mathematical Literacy teacher to participate in this research project aimed at determining teachers' perceptions of the relationship between learners' English proficiency and Mathematical Literacy performance.

Please note that:

- The information that your teacher provide will be used for scholarly research only.
- The teacher's participation is entirely voluntary. The teacher will have a choice to participate, not to participate or stop participating in the research. He or she will not be penalized for taking such an action.
- The teacher's views in this interview will be presented anonymously. Neither their name nor identity will be disclosed in any form in the study.
- An initial completion of a questionnaire is to be conducted that will take about 15 minutes to complete.
- The interview will take about 90 minutes long.
- Three lessons of the teacher will be observed for talking points in the interview.
- The record as well as other items associated with the interview will be held in a password-protected file accessible only to myself and my supervisors. After a period of 5 years, in line with the rules of the university, it will be disposed by shredding and burning.
- If you agree to have your teacher participate please sign the declaration attached to this statement.

I can be contacted at: School of Education, University of KwaZulu-Natal, Edgewood Campus, Durban. Email: shaggydawson@hotmail.com;

Cell: [REDACTED]

My supervisor is Professor Sarah Bansilal who is located at the School of Education, Edgewood Campus, Durban of the University of KwaZulu-Natal. Contact details: Email: BansilalS@ukzn.ac.za; Phone number: 0312603451.

Thank you for your contribution to this research.

DECLARATION

I..... hereby confirm that
I understand the contents of this document and the nature of the research project, and I
consent to my teacher participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so
desire. I understand the intention of the research. I hereby agree to participate.

I consent / do not consent to have the teacher complete a questionnaire

I consent / do not consent to have the interview recorded of the teacher

I consent / do not consent to have three lessons observed of the teacher

SIGNATURE OF PRINCIPAL

DATE

.....

Appendix F

Informed consent from teacher

Informed Consent Document

Dear Teacher,

My name Quintus Dawson (202512967). I am a PhD candidate studying at the University of Kwazulu Natal (Edgewood Campus). The title of my research is: An exploration of how teachers take account of the perceived relationship between learners' English proficiency and Mathematical Literacy performance. The aim of the study is to determine the perceptions of teachers and grasping teachers understanding if language proficiency plays a significant and, or problematic role in Mathematical Literacy performance. I am interested in observing two lessons of one of your Grade 11 Mathematical Literacy classes. To conclude I am interested in having an interview with you to discuss the topic at hand.

Please note that:

- The information that is collected will be used for scholarly research only.
- Your participation is entirely voluntary. You have a choice to participate, not to participate or stop participating in the research. You will not be penalized for taking such an action.
- Two Mathematical Literacy lessons will be observed by me and conclude with and interview.
- If you agree to participate please sign the declaration to this statement.

If you have any queries, I can be contacted at: School of Education, University of KwaZulu-Natal, Edgewood Campus, Durban. Email: shaggydawson@hotmail.com;

Cell: [REDACTED]

My supervisor is Professor Sarah Bansilal who is located at the School of Education, Edgewood Campus, Durban of the University of KwaZulu-Natal. Contact details: Email: BansilalS@ukzn.ac.za; Phone number: 0312603451

The UKZN research office can be contacted via email at HSSREC@ukzn.ac.za

Thank you for your contribution to this research.

DECLARATION

I..... hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire. I understand the intention of the research. I hereby agree to participate.

I consent / do not consent to being observed in two lessons and contributing in an interview.

SIGNATURE OF TEACHER

DATE

.....

Appendix G

Assent form to learners

Dear Learner

Mathematical Literacy is a subject that there is not too much research being done in. This means that there is still a lot to learn about teaching and learning in this subject, and this is a special interest of mine. I am conducting a research study and need to observe your learning in the classroom for 2 lessons.

I need your permission to observe your experiences in learning Mathematical Literacy in the classroom as part of my study. In particular, this means I will be observing your learning in the classroom.

Your name will not be used in the study and you have my assurance that the information I gather from this study will be used for academic research purposes only. If you do not wish to participate in this research, you are entitled to say so and then none of my observations of you will be used in the research study. Thank you for your co-operation.

If you have any queries, I can be contacted at: School of Education, University of KwaZulu-Natal, Edgewood Campus, Durban. Email: shaggydawson@hotmail.com;

Cell: + [REDACTED]

My supervisor is Professor Sarah Bansilal who is located at the School of Education, Edgewood Campus, Durban of the University of KwaZulu-Natal. Contact details: Email: BansilalS@ukzn.ac.za; Phone number: 0312603451

The UKZN research office can be contacted via email at HSSREC@ukzn.ac.za

Mr. Q. Dawson

Name: _____

I give Mr Dawson permission to observe me in the classroom. I understand that I will not be identified by name in any research report and that I am not under any obligation to give my permission for this research study.

Signed: _____

Appendix H

Ethical Clearance



07 August 2023

Quintus Dawson (202512967)
School Of Education
Edgewood Campus

Dear Q Dawson,

Protocol reference number: HSSREC/00003708/2021

Project title: An exploration of how teachers take account of the perceived relationship between learners English proficiency and Mathematical Literacy performance.

Amended title: An exploration of how teachers perceive and respond to language demands associated with the learning of Mathematical Literacy

Degree: PhD

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 05 August 2023 has now been approved as follows:

- Change in title

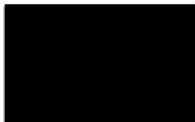
Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

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

Best wishes for the successful completion of your research protocol.

Yours faithfully



.....
Professor Dipane Hlalele (Chair)

/dd

Humanities & Social Sciences Research Ethics Committee
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Tel: +27 31 260 8350 / 4557 / 3587
Website: <http://research.ukzn.ac.za/Research-Ethics/>

Founding Campuses:  Edgewood  Howard College  Medical School  Pietermaritzburg  Westville

Appendix I

Turnitin Report

Chapters 1 to 12

ORIGINALITY REPORT

13%

SIMILARITY INDEX

12%

INTERNET SOURCES

6%

PUBLICATIONS

%

STUDENT PAPERS
