Adaptation of British mathematics textbooks for use in the United Arab Emirates

by

Chantelle De Wet

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Declaration

I, Chantelle De Wet, student number 04266072, declare that the dissertation, which I hereby submit for the degree Magister Educationis at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Chantelle De Wet

September 2018

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Ethics statement

I, Chantelle De Wet, student number 04266072, declare that the dissertation, which I hereby submit for the degree Magister Educationis at the University of Pretoria, is ethically compliant with regards to all aspects of this research.

Chantelle De Wet

August 2018

Dedication

I dedicate this research to every learner in the UAE that I had the privilege to teach during the last three years. You have taught me that perseverance knows no race, age, gender or culture and that dedication reaches far beyond any religion and school. You often struggled with language barriers and textbooks you did not understand, yet you guided me to become a better teacher, with a stronger understanding of the importance of contextualising content. I have grown professionally and personally during this time and I would like to acknowledge your impact on my own learning curve. I started this research journey with selfish goals but now reflect with holistic amazement.

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ABSTRACT

The United Arab Emirates (UAE) is a cosmopolitan country thriving on diversity but also governed by strict and conservative Islam rules. Education is considered a crucial part of the nation's development and large monetary investments have been made with the intention of raising the standard. Several international schools in the country have introduced international curricula, yet resources for these schools are sparse and ineffective. A qualitative case study was consequently conducted which applied critical discourse analysis (CDA) to explore why and how certain mathematics textbooks need to be adapted for more effective use. Literature gave definition and reference to the importance of mathematics textbooks in the developing classrooms as well as the threefold use of these textbooks: by the teachers for planning lessons, by the learners for study purposes and by the parents who assist them. While English is the primary language of instruction in international schools, more than 94% of the pupils at these schools are English additional language (EAL) learners. The New London Group's concept of multiliteracies shows that with purposeful adaptations, the efficiency of textbooks for EAL use can be improved and learner attainment substantially enhanced. Accordingly, two relevant textbook samples were chosen from the British curriculum for the study, specifically written for the International General Certificate of Secondary Education (IGCSE) mathematics examination. A subsequent thematic analysis suggested that the layout, language, examples and visual aids in the textbooks were not adequately adapted to teach the British mathematics curriculum effectively with EAL learners in an international classroom in the UAE. The layout and structure of the textbook were discouraging navigation throughout the textbooks. The vocabulary were not suitable for EAL learners and the lack of definitions were hindering understanding of mathematical concepts. Social, environmental and contextual examples used in the textbooks were irrelevant to the learners' reality and the visual aid became barriers to learning. My findings concluded that the adaptation of the mathematics textbooks would benefit teacher, parent and learner.

Keywords: international learners, literacy levels, developing classrooms, textbook use and relevance, mathematical understanding, contextual adaptations, critical theory, critical discourse analysis, multiliteracies.

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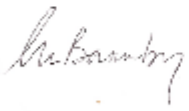
To whom it may concern

This is to certify that I, Alexa Kirsten Barnby, an English editor accredited by the South African Translators' Institute, have edited the master's dissertation titled "Adaptation of British mathematics textbooks for use in the United Arab Emirates" by Chantelle de Wet.

The onus is, however, on the author to make the changes and address the comments made.



List of abbreviations

ADEC	Abu Dhabi Education Council
ADEK	Department of Education and Knowledge
AED	United Arab Emirates Dirham
CDA	Critical discourse analysis
EAL	English as an Additional Language
IB	International Baccalaureate
IGCSE	International General Certificate of Secondary Education
ME	Moral Education
MoE	Ministry of Education
NLG	New London Group
NSM	New School Model
UAE	United Arab Emirates
UK	United Kingdom
USD	United States Dollar

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CHAPTER 1: ORIENTATION AND RESEARCH CHALLENGE

1.1. Introduction

To translate a passion for teaching into an academic transcript is not a task effortlessly completed. In order for the reader to comprehend my positionality, I opt for an autobiographical introduction. By doing so, I can address the background to my research, give a contextual perspective and explain real-life situations that led to this research. In this chapter, I will sketch the context of my research holistically, argue the decisions I made regarding theoretical lenses and contemplate my paradigmatic standing and research design. I will describe methodologies and introduce sampling strategies that will lead to data analysis in chapter 4 and an eventual evaluation of data in chapter 5. This may seem unconventional, but it will undoubtedly transpire enhance understanding when reading through the research.

1.2. Contextualisation

My research quest was born in January 2016, when I started teaching mathematics at a British international school in Abu Dhabi, United Arab Emirates (UAE). The school was merely three years old and still developing policies and gathering teaching resources. The whole school totalled 800 learners, ranging from ages 4 to 15, including Muslim, non-Muslim, Arabic and non-Arabic learners. I became a member of the secondary school staff, leading 170 learners between Year 7 to Year 11 towards a British qualification at the end of Year 11. The secondary school consisted of 16 British and Irish teachers and I was the first South African to join the school. This holds relevance, as I was the first teacher with experience in teaching learners who use English as an additional language (EAL) to ever teach at this particular school, so very few adaptations were made to teaching and learning in order to address the literacy of learners.

Within the first two weeks my enthusiasm was curbed by the realisation that learners' learning was not being optimised to reach maximum potential. The learners' social and environmental context, their English proficiency and their overall literacy levels were often ignored by teachers, leading to disciplinary disruptions and little learning taking place. Some teachers attempted to create their own, more effective worksheets and resources but the process proved to be time-consuming and unsustainable.

Since the school followed the British curriculum, textbooks imported from the United Kingdom (UK) were used. At the time, the Ministry of Education (MoE), in conjunction with

the Abu Dhabi Education Council (ADEC), were the leading authorities on education in the UAE (Tabari, 2014) and they enforced very strict rules on all teaching done in both private and government schools. In September 2017, the MoE and ADEC amalgamated but the basic rules and regulations are still relevant under the new leadership of the Department of Education and Knowledge (ADEK).

Within the first three months of teaching, I had to tear out pages from textbooks where Israel was mentioned, as it is illegal in the UAE to refer to Israel as a country. Using black markers, all pictures of pigs had to be covered, as pigs are seen as offensive in the Islamic religion. I also helped the Biology teacher erase all evidence in textbooks that humans can be classified as animals, since this is sinful and punishable by law in the conservative desert country that is the UAE as described by Tabari (2014). In the mathematics textbook, in the chapter dealing with weather conditions, there was a picture of a girl on a beach, wearing a bikini and holding hands with a boy wearing only swim shorts. I had to cover this picture with a black sticker before handing it out to learners. Women have to dress very conservatively in the UAE, covering their shoulders, knees and collarbones. Holding hands in public with someone from the opposite sex, even if you are married, is seen as offensive and not suitable for the UAE context. The British textbooks may be wonderful resources for the curriculum content but the social context of the UAE often proved to be a hindrance to the contextualisation of content for the learners.

Apart from the physical changes that had to be made to these textbooks, I also discovered that the English literacy levels of the learners in my classroom were not sufficient to understand the content of the textbooks. Less than 6% of all the secondary school learners spoke English as a home language and the overall English proficiency of the learners was very poor. I had learners in my class who were unable to ask for a pencil in a full sentence, most learners could not distinguish between instructions like *simplify* and *solve* and a limited few knew how to use the index of a textbook. The Arabic language uses a different alphabet, based on sounds, not letters, thus spelling does not matter to the learners as much as it does to English-speaking learners. Arabic sentences read from right to left, making the textbooks from the UK seem strange to the majority of learners.

In particular, when using the content of the mathematics textbook, problems quickly arose. References to the imperial measuring system are made without explanation, so most examples

relating to measurement are in inches, pounds, pints, and miles. In the UAE, the metric system is commonly used and learners are only aware of centimetres, kilograms, litres and kilometres. I was shocked to learn that only three learners in Year 8 had ever seen rain, challenging me to explain rainfall per year when dealing with the units on data and statistics. The currency of the UAE is dirhams and fills, while most examples in the textbooks are in pounds and pennies, with some reference to dollars and euros. Since the UAE is one of the very few countries where no income tax is paid and it is illegal to charge interest under Islamic law, the units on percentages and personal finances brought challenges relating to content.

I had to adapt almost every worksheet, exercise and example used from the textbook so that I could use it effectively in class. Planning every lesson took hours, just to make sure that it was contextually relevant for the learners. At the end of Year 11, learners have to write a standardised assessment, called the IGCSE (International General Certificate for Secondary Education). The preparation for these examinations rely on specific content being taught and allows for very little deviance from the curriculum structure. This begs the following two questions: Why is the context of teaching important in a mathematics classroom and why would local learners choose to follow the British curriculum if the content is not relatable for them?

The first question I could answer instinctively from personal experience. If I could make the content of mathematics relatable for the learners, then they would be able to grasp the basic concepts more easily. Shellard and Moyer (2002) state that mathematical problems cannot be deciphered, understood, comprehended or made a learner's own unless there is a basis on which to build this knowledge. Henning (1996) maintains that if a mathematical concept is understood by the learners in their personal capacity, adaptations can be more readily made without confusing the primary knowledge. I experienced this first hand in my classrooms. After explaining a word problem using camels as examples (instead of pigs as used in the textbook), learners understood the conceptual problem and could apply the principles to other problems, regardless of context. The context is thus important as a starting point and when understanding that the textbook is often the most primitive starting point for teachers in the UAE, as I will prove in chapter 2, and the research gains trustworthiness.

The origin of the second question lies in the infancy of the education system in the UAE. Previously, the people of the UAE lived a mostly nomadic life and education was handled informally by families as very few schools existed. After the UAE's independence from Britain

was declared on 2 December 1971, Abu Dhabi was proclaimed the capital of the seven emirates (provinces) and the necessity for an education system was realised (Ghamri, 2012). the education reform that started in 2006 was led by the ADEC and although improvements can be seen in the new schools being built, the quality of teachers being appointed and the resources accumulated (Tabari, 2014), the education system is still young and inexperienced (Ghamri, 2012). In 2009, the ADEC announced that English would be the only language of instruction for mathematics and science and so "a great education reform began" (Khalaf, 2009:12). Committed to improving the overall English literacy levels in the country, the ADEC started recruiting more international teachers in all subjects but especially in mathematics and science (Alzahrani, 2014). Government schools were erected in all emirates to accommodate local children but, as time passed, more expatriates gathered in the UAE and so the demand for international schools was born (Ghamri, 2012).

Government schools are free of charge, follow the New School Model (NSM) curriculum established by the ADEC, use the textbooks specially written for them and are attended exclusively by Arabic-speaking Muslim learners. On the other hand, there are currently 185 international schools in Abu Dhabi (*Education History in Abu Dhabi*, n.d.) and of these, 48 follow the British curriculum (*Schools in the UAE*, n.d.). The international schools are not solely for non-Arabic learners and many local children attend these schools, making the demography of the international schools more complex. Since 2014, more local learners have started to immigrate to the international schools (*Schools in the UAE*, n.d.), driven by parents who regard English as being the language of the future (Alzahrani, 2014). It is thus their choice to attend international schools but they do not necessarily have the required literacy levels to thrive in these schools.

1.3. Rationale

In August 2016, my contract with the school ended and I joined another British international school in Abu Dhabi. This school is much larger than the previous one, with more than 3500 learners ranging from ages 4 to 18. The new school also follows the British curriculum and the demography of the learners in my class did not change significantly. Approximately 5,5% of learners speak English as a home language and only 1,2% of learners have personal knowledge and experience of the UK. The same prescribed textbooks are used in both schools and by implication the sample of my research thus remained unaffected. I spent hours planning lessons from various British textbooks, adapting the content, language levels, examples and context so

as to render them suitable for the learners in my class. Saving time and being more able to teach concepts to the learners in my class would thus serve as my personal rationale for this study.

Mathematics is a core subject, along with English and science, in the majority of schools throughout the world (Shellard & Moyer, 2002) and the UAE is no exception. Mathematics is required by most sciences (Norris, 2012) and it also provides access to a large number of undergraduate courses at tertiary institutions. In the British curriculum, mathematics is compulsory up to Year 11, making the research relevant.

In the modern-day classroom, technology often precedes the textbook as a resource (Cox, 2016), but in countries where the education system is still developing, like the UAE, textbooks still play an important role (Al Qaydi, 2016). The textbook is especially important in classrooms where language barriers are experienced (Snyder, 2014) and where the textbooks may be the only source of information for the learner when studying at home (Rezat, 2009). Valverde, Bianchi, Wolfe, Schmidt, and Houang (2002) highlight that the structure of the mathematics textbook should be adapted to constructively appreciate the target audience, so that the learners can identify with the content more and become the authors of their own learning experiences (Sujee, in print).

As a mathematics teacher in an EAL classroom, I am aware of the challenges learners face when being presented with a textbook in which the English literacy is simply out of their grasp. When initially reading on multiliteracies (Engelbrecht, in print; Jewitt, 2014; NLG, 1996), I became entranced by the possibilities of educational potential that can be unlocked by simply adapting the mathematics textbook. From my own experience, learners believe that they do not understand mathematics, when in truth they simply do not relate to the content of the textbook.

I believe that my research can have an impact on all Middle Eastern countries where the cultures and the literacy levels are similar, but I use Abu Dhabi in the UAE as a starting point, as this is what is known to me. The contextual adaptation of British mathematics textbooks in international schools in the UAE will not only reduce the workload of the teachers but also possibly lead to a more effective resource that learners can use at home.

1.4. Aim of the study

In my research, I critically investigated the mathematics textbooks used by teachers and learners in international schools in Abu Dhabi. I aimed to identify practices used in these textbooks that are not suitable for learners studying in the UAE, while still preparing them sufficiently for the final examinations set by the British curriculum.

In addition, I sought to negotiate ways in which these textbooks could be adapted to enhance their functionality as teaching and learning resources. In view of the fact that the success of my teaching has been hindered by a lack of consideration for context in the textbooks, it was assumed that the contextual adaptation of British mathematics textbooks in international schools in the UAE might just be the solution.

1.5. Research questions

1.5.1. Primary research question

How should British mathematics textbooks be adapted to consider the context of international secondary schools in Abu Dhabi?

1.5.2. Secondary research questions

These subsidiary questions will serve as a guideline for my research to ensure that I keep focused on answering my primary research question.

1.5.2.1. How can the literacy levels in British textbooks be adapted to consider the literacy standards in an international secondary school in Abu Dhabi?

1.5.2.2. How can the content of the British mathematics textbook be adapted to consider environmental differences in Abu Dhabi?

1.5.2.3. How can British mathematics textbooks be adapted to consider the social context of the UAE?

1.5.3. General assumptions

To address the primary and secondary research questions as set out in sections 1.5.1 and 1.5.2, I made the following general assumptions:

Based on my personal teaching experience in two British schools, my working assumption is that more than 70% of the learners in international schools do not speak English as a home language, even though English is the primary language for learning and teaching. I assume that most teachers in British international schools use textbooks prescribed by the British curriculum for lesson planning, examples and exercises and that these textbooks are available for learners to study from, not only at school but also at home.

1.5.4. Concept clarification

To assist in obtaining a better understanding of my research, eliminating possible confusion or misunderstandings and putting the research questions more specifically in context, certain concepts need to be defined.

1.5.4.1. Local learners, teachers, and schools

When referring to children attending schools, I prefer the term "learners", as it suggests a pupil still "learning" at school level, while "student" is often claimed by tertiary pupils "studying" a more specific discipline. In this study, Arabic-speaking Muslim learners and teachers are regarded as "local learners and teachers". They do not necessarily have a UAE passport but were likely to have been born in the UAE and have been living in the UAE for the better part of their life. If a baby is born in the UAE, he/she will still be registered in the country of his/her parents' origin and be issued a passport from there. A person can only claim citizenship of the UAE if both parents are Emirati (born from nomadic tribes originally from the UAE). The term "local schools" encompasses national, government-funded schools as started by the ADEC and in which only local learners may enrol.

1.5.4.2. International learners, teachers, and schools

In January 2015, the International Schools Consultancy (ISC) listed the UAE as having 507 international schools (*Education History in Abu Dhabi*, n.d.), 185 of which are situated in Abu Dhabi, the capital emirates (*Schools in the UAE,* c.2009). The private education sector, which consists of international schools with curricula from all over the world, has seen 36,6% allocation of learners in 2000, 49,3% in 2005 and 56,2% in 2009 (*Social Statistics: Education,*

2017). Both local and international learners may attend these schools, where school fees are expensive, ranging from 15 000 to 120 000 dirham (AED) per year. “International learners” refers to learners who were born in other countries and currently residing in the UAE as expatriates. International teachers originate from several different countries, including the United States of America, South Africa, Canada, Australia, India, Pakistan and New Zealand and live in the UAE under the sponsorship of the international schools (Khalaf, 2009).

1.5.4.3. British Curriculum

Also known as the National Curriculum for England and established in 1988, this is a broad and balanced system which covers all the major arts, sciences (including mathematics, physics, chemistry and biology) and humanities subjects. With a wide-angle view and a liberal approach, it is valuable for keeping track of progress and encouraging achievement all the way from primary school to college level. A detailed framework gives learners an easy-to-navigate map to help them identify, work towards and achieve their academic goals. The British curriculum includes regular national benchmarking and culminates in the International General Certificate of Secondary Education (IGCSE) at the end of Year 11 (*Accreditation and affiliation*, c.2010).

1.5.4.4. Literacy levels

Literacy can be defined as the "ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts. Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society” (*UNESCO Education in the UAE*, c.2009:3). Multiliteracies forms part of my conceptual framework and I thus regard literacy as a multidimensional concept, instead of regarding it only as a language. For the purpose of this research, the literacy levels of learners will not be quantitatively measured, but rather refer to a subjective understanding and experience of the researcher in the classroom situation.

1.5.4.5. Environmental differences

An environment is “the aggregate of surrounding things, conditions, or influences; surroundings; milieu” (*Environment*, 2017:1) and can also refer to “the social and cultural forces that shape the life of a person or a population” (Ahmed, 2010:12). When referring to “environmental differences” in the research, these two definitions apply.

1.6. Conceptual framework

Critical theory draws strongly on the notion of social reality as a "construction process" (Maree, 2016:63), while the theory of multiliteracies stems from the changes made in society (Engelbrecht & Hugo, in print), ensuring that these two frameworks act to strengthen and complement one another when working in the realm of a society. My research will benefit from both these frameworks, especially considering that I will also be using a critical paradigm and critical discourse analysis (CDA), which will be discussed later.

1.6.1. Critical theory

Bohman (1991), Hesse-Biber and Leavy (2011) and Horkheimer (1993) claim that critical theory needs to be explanatory, practical and normative, it should explain what is currently wrong with the social reality by identifying the changing actors and it should provide achievable goals for transformation. Since analysing a textbook is both explanatory and practical, I would be able to identify the problematic sections and make suggestions on how the textbooks can be adapted for better implementation. According to Maree (2016:64), the "critical educational researcher aims not only to understand or give an account of behaviours in societies but to change these behaviours" and this will be my own personal suit when conducting my research.

Even though critical theory assumes that social reality is created in history (Maree, 2016), critical researchers will always seek to transform this reality into something better (Horkheimer, 1993). This links well with the concept of multiliteracies, since multiliteracies claims to develop literacy without erasing the cultural or social identity of the people involved (Engelbrecht & Hugo, in print).

1.6.2. Multiliteracies

As society develops and changes so do the needs of learners. Consequently, the education sectors have been forced to leave literacy as a single entity behind and to embark on the journey of discovering many literacies (Engelbrecht & Hugo, in print). In 1996, the New London Group (NLG) gave birth to the idea of multiliteracies (Roswell, Kosnik & Beck, 2008) as a response to the exclusion of non-mainstream learners in schools (Engelbrecht & Hugo, in print). They described this as a new approach to literacy pedagogy (NLG, 1996). Crawford (2003) suggests that textbooks need to adopt a multimodal approach if they are to fully lead

both learners and teachers towards successful learning. Accordingly, different forms of literacy need to be understood.

Jewitt (2014) defines multiliteracies as a multimodal form of expression that deals with meaning-making processes in various ways, using a variety of resources. The NLG (1996) noted many varying forms of literacy, including the language of science and mathematics. Thus mathematical literacy encompasses certain concepts, principles and skills that have to be understood before a learner can gain mathematical knowledge (Haylock, 1991).

Multiliteracies as an extension of society (Cope & Kalantzis, 2003) implies that a parallel can be drawn between critical theory and multiliteracies, as literacy is one of the primary social skills acquired (Jewitt, 2014). The NLG (1996) is not subtle when it urges for education to move away from a single literacy, whether it be oral or written, to a new era encompassing a better understanding of cultural and linguistic diversity. In the UAE, cultural diversity and language literacy levels hinder academic progress when solely depending on the textbook, that is, a monoliteracy, hence multiliteracies will broaden the understanding of the adaptations that have to be made.

The notion of multiliteracies rests on four pillars, as set out by the NLG (1996), namely, overt instruction, situated practice, critical framing and transformed practice. Roswell et al. (2008) refers to *overt instruction* as the teacher's active intervention in adapting multiliteracies into practice in the classroom, whereby learners can make textbook content a reality in their own world. In *situated practice*, the active teacher (Cope & Kalantzis, 2003) links the learner's pre-knowledge and own experiences to new knowledge (Engelbrecht & Hugo, in print). *Critical framing* has relevance to my research, as it emphasises the symbiotic relationship between written text and social context (Jewitt, 2014) and all changes are made with equal opportunity and fairness in mind (Engelbrecht & Hugo, in print). According to Engelbrecht and Hugo (in print), *transformed practice* relies on innovation and creativity in the classroom, where learners transform their own learning into something recognisable for the learners.

When working from and with a textbook (or multiple textbooks) in a mathematics classroom, one should not adhere to one single literacy, namely "mathematics" as a language (Crawford, 2003). Moreover, conceptualisation cannot reach its full potential if the textbook is the only resource (Khalaf, 2009), especially if the textbook has not been adapted with the specific

learner in mind (Snyder, 2014). In light of this, the theoretical lens of multiliteracies provides ample and differentiated ways of support for teachers and learners (Jewitt, 2014) in the quest to become part of an effective global community (Roswell et al., 2008). When adapting and changing the content, the social context portrayed and the literacy levels in the prescribed textbooks the researched phenomenon is viewed through the lens multiliteracies theory and what it can contribute to this research problem.

1.7. Paradigmatic perspectives

According to Nieuwenhuis (2016), our assumptions and/or beliefs about the fundamental aspects of reality, which give rise to a particular worldview, are encompassed in the definition of the word *paradigm*. By recognising the complexity and interrelatedness of phenomena and paradigms, Maree (2016) questions the formal and final definition of a fixed reality. Silverman (2013) argues that all paradigm perspectives are interlinked in one way or another and that usable research cannot be done in isolation. The choice of one primary paradigm may serve as a logical guideline for research (Creswell, 2013) but when secondary paradigms are subtly introduced, the research becomes more valid and credible (Silverman, 2013). I will work mainly within the critical paradigm, linking the critical nature of my study (how to change the current circumstances) to all other research decisions that I make, for example the use of critical theory and multiliteracies as my conceptual framework.

1.7.1. Critical paradigm

The critical paradigm gave birth to critical theory (Maree, 2016) and marks the moment in history where language started constructing our reality (Deetz, 1996). This entails our conceptual system and the definitions of our realities, which are created through language (Giroux, 1988). The linguistic features of any society guide and limit the context of that society's perceptions and observations (Deetz, 1996).

The critical paradigm is well suited to qualitative research (Giroux, 1988), as the linguistic interpretation of studies conducted with the aid of a critical framework links successfully with observations (Giroux, 1998; Deetz, 1996). Rather than naming problematic instances or being descriptive about the research, the critical paradigm challenges the guided research assumptions (Kincheloe & McLaren, 1994), starting with what is good and moving towards the possibility of improvement (Giroux, 1988). Within the critical paradigm, the researcher not only describes the research but is also constantly attempting to change the situation (Deetz,

1996; Giroux, 1988; Guba & Lincoln, 1994). This is what I aim to do in my research: not only to describe what is missing from the mathematics textbooks but also to propose changes to ensure that the textbooks become a more effective, workable resource.

1.7.2. Ontology

Ontological questions regarding reality are concerned with the social implications and conceptions of how society interprets reality (Nieuwenhuis, 2016). After careful consideration, I will follow the "position held by most qualitative researchers following an interpretivist or critical theory perspective" namely *idealism* (Nieuwenhuis, 2016:58). For qualitative researchers, ontological idealism is one of their philosophical foundations (Bubner, 2003). Thus, it is asserted that reality can only be defined by the human mind and socially constructed meanings (Nieuwenhuis, 2016).

Qualitative researchers often support the idea of multiple realities (Dicker, 2011) and strive for an ideal world (Foster, 1982) where historical wrongs are being corrected (Bubner, 2003). In terms of an idealistic philosophy, the critical researcher looks at history through an ideal lens (Dicker, 2011) and searches for the ideal solution for the future (Foster, 1982). When working with textbooks, their social context and history cannot be ignored (Ahmed, 2010). Crawford (2003) explains that textbooks cannot be used in isolation and that it is important that the social context be taken into consideration when choosing textbooks. Foster (1982) adds in this regard that historical events also have an influence on this social context.

Idealism aims to right all the wrongs committed in the past (Dicker, 2011) and the idealistic researcher will not stop until the ideal future has been created (Bubner, 2003). Looking critically at the mathematics textbooks, I aim to discover the concepts and problems that have a negative influence on the learners' learning, owing to the way they restrict of the learners' social contextualisation of the textbook content. Striving for a textbook that is accepted by teachers and learners and its use is increased would be the ultimate ideal.

1.7.3. Epistemology

While ontology begs the question *what do we know?* epistemology relates to *how* things can be known (Nieuwenhuis, 2016). Within the theory of knowledge and research, epistemology asks questions pertaining to methods and trustworthiness and the distinction between justified belief and opinion (Guba & Lincoln, 1994). Nieuwenhuis (2016) identifies three main issues

regarding epistemology in social research: the relationship between the researcher and the researched; the objectivity of knowledge; and the question of whether the results are generalisable (Maree, 2016).

The discussion on epistemology starts at the point of acquiring knowledge (BonJour, 2002). Immanuel Kant made the two philosophical terms *a priori* and *a posteriori* popular in 1781 (Hawthorne, 2005) when distinguishing between pre- and post-knowledge. A priori knowledge is non-empirical (BonJour, 2002) and is gained independently of experience, usually through logical reasoning (Morton, 2002). A posteriori knowledge, on the other hand, is gained only through experience (Morton, 2002) and is thus empirical in nature (BonJour, 2002). In the idealistic researcher's frame of reference, most knowledge is attained a priori (Morton, 2002) but when thinking within the critical paradigm and idealism as ontology, the empirical value of knowledge gained proves to be invaluable (Hawthorne, 2005). This helps to answer Nieuwenhuis's (2016) first and second dilemma, as mentioned above, when the objectivity of knowledge comes into question.

Nieuwenhuis (2016:67) states that "the relationship between the researcher and the researched is interactive … and the researcher cannot be objective". However, according to BonJour (2002), Bubner (2003) and Morton (2002), this is not problematic as long as the researcher keeps a validated research diary and is constantly monitored by factual events within the research. Modified transactional or subjectivist epistemology teaches us that we cannot separate ourselves from what we know and this inevitably influences inquiry (Giroux, 1988). When combining transactional epistemology and idealism, we get to a transcendent idealism, first explained by Kant in 1787 (Morton, 2002), which guides the researcher to marry a priori knowledge with a posteriori knowledge (Hawthorne, 2005). Within the critical paradigm and the framework of critical theory and multiliteracies, transcendent idealism will be my quest.

1.8. Research approach

In the search for a better understanding, quantitative research is deemed most suitable when doing research that is systematic and objective, using numerical data from a selected sub-group of a larger quantifiable population (Maree, 2016). According to Cohen, Manion and Morrison (2007), three important elements of quantitative research are objectivity, numerical data, and generalisability. Because I will apply critical theory and multiliteracies as the conceptual framework in line with idealism and a subjectivist epistemology in my research, my paradigm

is more likely to be subjective. Therefore, because no numerical data were used, no participants introduced and no surveys done, a quantitative research design was not deemed worthy of my aim of study.

Qualitative research is distinguished by linguistic dependability and meaning-based data-analysis (Polkinghorne, 1989) but involves a variety of different approaches (Silverman, 2013). Creswell (2013) maintains that qualitative research is conducted when there is a problem or an issue that needs to be explored. This suited my cause well, and therefore a qualitative research design is considered most appropriate.

The use of a qualitative methodology opens up possibilities for researchers to study a specific case within a complex context by using different tools, such as interviews, observations and documents (Nieuwenhuis, 2016). Qualitative research is often linked to the subjective interpretations of the researcher (Creswell, 2013) and Nieuwenhuis (2016) argues that the choice of a qualitative design starts with the researcher's inclination towards explanation and obtaining an understanding of a problem. It should be noted here that Hammersley (2008) adds that a qualitative approach is far more complex in its descriptions than a quantitative one. Hence, Nieuwenhuis (2016) points out that qualitative research should not be equated to interpretivism, although Sandelowski (2010) argues that all research, whether qualitative or quantitative, entails some form of interpretation. When contextualising mathematics textbooks, there is a strong focus on interpretations and descriptive language, which once again reinforces my need to apply qualitative research.

Qualitative research aims to understand certain behaviours and seeks to gather information about *why* a problem exists (Baškarada, 2014). With a strong basis in the field of sociology, qualitative methods examine the *why* and *how* of decision-making, not just *what*, *where*, *when*, or *who* (Denzin & Lincoln, 2000). When applying a CDA in a qualitative research design, the answer to how the problem can be solved becomes a possibility (Hammersley, 2008). Finally, Terre Blanche, Durrheim and Painter (2006) reinforce my choice of research method and it appropriateness, stating that qualitative research entails an in-depth exploration of a situation within a specific context.

Qualitative research is thus considered the most suitable option for my research when analysing British mathematics textbooks in the UAE.

1.9. Research design and methodology

Good researchers know that a choice of research methodology should not be predetermined but rather chosen in line what you are trying to investigate (Silverman, 2013). Terre Blanche et al. (2006) encourage researchers to examine all methodologies before settling on one that will fit their research design.

1.9.1. Critical discourse analysis

In my research, a CDA method was used to analyse the appropriate contextualisation of mathematics textbooks in the UAE. This analysis was conducted through the lens of the critical paradigm, thus critical theory and multiliteracies were applied as the conceptual framework. *Critical* implies that nothing is taken for granted (Wodak, 2001); that complex situations need to be opened up (Wodak, 1996) and that ideologies should be challenged for the greater good (Rogers, 2003). According to Wodak (1996), proposing alternatives to complex problematics is also part of being critical. Wodak (2001) and Van Dijk (1993) believe that, by contrast, any kind of dogmatism is opposed to being critical.

CDA stems from linguistic formalities within a social context (Wodak, 2001) and since schools form a part of the social structure of a community, textbooks can be seen as such a linguistic formality (Ahmed, 2010). Van Dijk (1993) asserts that CDA never set out to be a single theory nor to be defined by a sole methodology. CDA "tries to point out those features of a text that are most interesting from a critical perspective" (Huckin, 2004:3) and Wodak (1996) adds that CDA is a culmination of various approaches that simply share a theoretical base. Wodak (2001) argues that there is tension between the ideologies in theory and the real-world social complexities, and that CDA recognises the differences. The so-called *world* depicted in mathematics textbooks is a far cry from the reality and context of the UAE (Snyder, 2014), making CDA even more appropriate for my research.

1.9.2. Case study

When working with a qualitative research design, a case study often works well (Stake, 1995). Eisenhardt (1989) maintains that a case study is ideal when a small, specific sample is required to complete the research successfully. Case studies are usually done when handling documents and when the research is bound by time and place (Yin, 2009). Hence, a case study design was deemed ideally suited for my research.

1.10. Data

1.10.1. Data collection

Maree (2016) explains that data collection and analysis often occur at the same time in qualitative research and, when considering the application CDA, a research diary, along with other formal samples, would be deemed sufficient (Wodak, 2001). Document analysis is a type of qualitative research in which documents are reviewed (analysed) by the analyst (researcher) (Patton, 1990). According to Ahmed (2010), education textbooks form part of the public domain and are consistent with the social context. Silverman (2013) argues that texts are heuristic devices for collecting data, where words and images help the researcher form a better understanding of the context and content of the research being conducted.

1.10.1.1. Site

In a qualitative research study, locating the site of research is the first step in data collection (Creswell, 2013). According to McMillan and Schumacher (2001), it is essential to select a research site that is suitable and feasible for the type of research to be conducted. This research was carried out in Abu Dhabi, UAE, where I was living at the time and teaching at an international school where the British curriculum was followed. In view of the fact that the research comprised the analysis of textbooks, no formal research site had to be identified.

1.10.1.2. Sample

Purposive sampling is the most common approach adopted in qualitative research (Nieuwenhuis, 2016). The samples are chosen with a specific purpose in mind and are a representation of the criteria set by the researcher (Ritchie & Lewis, 2003). Patton (2002) outlines 16 types of purposive samples but the common thread is that all samples are selected with predetermined relevance in mind. *Homogeneous* samples (Patton, 2002) have similar characteristics and I will therefore choose mathematics textbooks specifically published for the British IGCSE curriculum (Years 10–11), which are used by international schools in the UAE. These samples can also be defined under *typical case sampling* (Patton, 2002) because the textbooks can be seen as "typical" mathematics textbooks within the British curriculum.

Patton (1990) notes that when conducting qualitative research, there are no rules for sample size and Maree (2016) adds that sample size is determined by your research aim. Sandelowski (2010) warns that the sample should not be so small that data saturation would not be possible. When handling documents in a critical manner, the sample size is determined by the available

resources (Reisigl & Wodak, 2001) and the time constraints on the research (Rogers, 2003). I chose two mathematics textbooks that are most commonly used and readily available in international schools in the UAE. Accordingly, the following British textbooks were used:

1. Edexcel International GCSE Mathematics A, Books 1 & 2, ISBN: 978 0 435966 91 1, Published by Pearson Education Limited (Essex, UK)
2. Edexcel International GCSE (9-1) Mathematics A, Books 1 & 2, ISBN: 978 0 435 18144 4, Published by Pearson Education Limited (Essex, UK)

Both sets of textbooks were written in the UK for use in international schools using the British curriculum outside the UK in Years 10 and 11, with the final examination of IGCSE (at the end of Year 11) in mind.

1.10.2. Data analysis

Three analysis strategies are accepted in the qualitative research field, including the interpretive framework, the systematic approach and the traditional approach (Creswell, 2013). When analysing data in a case study, Silverman (2013), Yin (2009) and Maree (2016) suggest following the traditional approach, as identifying patterned regularities and contextualising them in the literature framework are considered essential. Since I followed a CDA method when analysing the mathematics textbooks, certain problematic areas were identified (Wodak, 1996) and I explored solutions to these in my research diary (Maree, 2016).

In a case study, Creswell (2013) suggests extending the traditional approach to the use of direct interpretation and to the development of natural generalisations of what was discovered. Nieuwenhuis (2016:108) explains that because of the multiple data-collection strategies implemented in case studies, the researcher will have to adapt his/her evaluation strategies and analysis process to "triangulate data in order to strengthen the research findings and conclusions".

Thematic analysis is one of the most common forms of analysis in qualitative research (Braun & Clarke, 2006). This method emphasises pinpointing, examining and recording patterns from the data collected and categorising these patterns into themes (Babbie & Mouton, 2001). Thematic analysis is best thought of as a holistic term for a variety of different approaches, rather than a single method (Braun & Clarke, 2006). A coding process comprising six phases, as set out by Braun and Clarke (2006), was a logical choice in my research. After familiarising

myself with the data, I generated initial codes, searched for themes among these codes, reviewed the themes carefully, then defined these themes before producing the final report.

As mentioned previously, CDA critically processes the text with the social context in mind (Rogers, 2003), which is what I proposed to do. Since I was teaching at the school in question at the time of the research, my research diary was relevant (Maree, 2016), and by using multiliteracies as a framework, I inquired into the possible adaptations to be made to the textbooks. Using two textbooks on the same subject (mathematics) prescribed for the same year groups (Years 10–11) in the same curriculum (British) I was also able to identify trends. Initial coding led to emerging themes, which structured the data I collected. My research diary proved invaluable in this regard because this is where observations on the social context were noted (Maree, 2016) and compared to the primary texts. This all forms part of a CDA.

1.11. Ethical considerations

Love and Pimm (1996) explain that it is very difficult to obtain reliable information on learners' use of textbooks, which probably explains the dearth of research in this particular field. A document analysis requires few ethical considerations and since neither the school nor the learners were involved in my research, the samples were determined very early on and no ethical issues has to be considered.

1.12. Quality assurance

Nieuwenhuis (2016) mentions credibility, transferability, dependability, and confirmability as considerations when dealing with quality assurance (Maree, 2016). Credibility refers to the congruency of the research finding with reality (Nieuwenhuis, 2016) and in this was addressed in this research by keeping a research diary. In my research diary, I am able to contextualise the actual classroom and compare it to the content of the textbooks being analysed. In addition, I used my research diary to note conversations with colleagues as well as process additional information. As qualitative researchers tend to reject generalisation as an initial goal (Denzin, 1983), Lincoln and Guba (1985) suggest that transferability be used in qualitative research. This implies that readers and other researchers extract the data and apply them to their own realities (Nieuwenhuis, 2016). Researchers dealing with the local culture and EAL learners in the UAE would be able to read my research and possibly transfer the findings to their own research, a quality assurance marker with case studies (Yin, 2009). In addition, dependability is preferred to "reliability" in qualitative research (Nieuwenhuis, 2016) and is closely linked to

credibility (Lincoln & Guba, 1985). Dependability refers to the changes being made throughout one's research, especially in qualitative research (Maree, 2016). Keeping journals and memoing throughout the research process and keeping track of all the changes as they occurred strengthened the dependability of my research (Nieuwenhuis, 2016). Finally, confirmability is described by Lincoln and Guba (1985) as the neutral stance as maintained by the researcher. According to Nieuwenhuis (2016), researchers can reduce their bias by admitting their predispositions and accepting that every study will have its limitations.

1.13. Possible limitations and delimiters

The lack of participants might be a possible limitation, but memoing, keeping a research diary and constant reminders of this potential shortcoming will serve as an additional measurement of trustworthiness (Maree, 2016). My bias as a researcher served as a constant reminder of possible limitations; however, in CDA and the critical paradigm, subjectivity is not a constraint on the narrative. As delimiters of the research, I analysed the British mathematics textbooks used in international schools in Abu Dhabi for preparation for IGCSE examinations. I did not look at Years 7–9 textbooks nor textbooks suited for American or International Baccalaureate (IB) curricula.

1.14. Conclusion and expectations

The idea of adapting a textbook so as to make it a more effective resource not only has research value but also has the potential to alleviate pressure on teachers, myself included. In this chapter I discussed possibilities pertaining to textbook use in the UAE in detail. I was inspired by the existing literature to venture on this academic journey.

In Chapter 2, I conduct a detailed literature review of the current use of textbooks in the international mathematics classroom, as well as reviewing my contextual use of textbooks in my own classroom in Abu Dhabi. Accordingly, my intention is to deepen my understanding of the UAE cultural context by examining current literature on the subject. Further, the research methodology and design will be explained in detail in Chapter 3, simultaneously addressing the paradigmatic perspectives and the conceptual framework of my research. In Chapter 4, the data collected will be analysed and the findings will be discussed. Chapter 5 will serve as a celebration of the data collected and analysed when linked and compared to the existing literature and my own recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

Chapter 1 of this dissertation served as an introduction and brief overview of my research. This chapter, Chapter 2, will delve specifically into the research already conducted and how the findings can possibly influence my research. I follow the traditional literature review as described by Maree (2016). My research scope is structured to depart from an international classroom perspective and is then funnelled into the UAE educational perspective. Finally, I conclude with the British schooling system in Abu Dhabi, grounding my positionality.

Education encompasses the transference of knowledge, skills and attitudes from one generation to the next (Tabari, 2014). While history once relied on people's stories and oral transmissions, later years saw the invention of the printing press and suddenly knowledge could be collated in book form (Alzahrani, 2014). When education became more formal and structured, curricula and textbooks were developed (Kline, 1974). As part of the developing curricula, knowledge was categorised into subjects in order to better prepare students for life after school (Kline, 1974). Ultimately, these subjects became practice and included language, science, psychology and mathematics (Tabari, 2014).

The importance of mathematics in schools has seen a lot of debate in recent years (Abosalem, 2016) but mathematics is still a core subject, along with English and Science, in most schools throughout the world (Shellard & Moyer, 2002; Tabari, 2014; Norris, 2012). Not only is it required in most sciences courses at tertiary institutions (Norris, 2012) but it also provides access to most undergraduate courses at university level (Alzahrani, 2014).

Swanepoel (2010) states that defining the concept of a "textbook" is no easy task. Variations in pedagogic styles, the way written texts are implemented in classrooms and their cultural, historical and philosophical frameworks all influence a subjective definition of a textbook (Khutorskoi, 2006). Johansson (2006) confirms the complexity of the definition by adding that no text is impersonal, while Norris (2012) explains that every teacher will read from a text what they deem important and worthy, even if only to a small extent. Educational researchers prefer definitions relating to books specially written for educational purposes (Tabari, 2014), most often published by accredited publishing houses (Norris, 2012) and for primary use in didactic situations (Swanepoel, 2010). The textbooks should contain the content, information,

activities and examples necessary to attain the stated outcomes (Khutorskoi, 2006). Ogan-Bekiroglu (2007) also points out that a facilitator function is needed when using a textbook and Swanepoel (2010:49) describes a textbook as "a source of potential learning". Kline (1974) argues that a textbook without a teacher cannot be used to its maximum potential.

Since textbooks are still considered to be one of the most frequently used learning support materials (Swanepoel, 2010) and the availability of developed textbooks can be a critical factor when reforming an education system (Johansson, 2006), the textbook needs to be adapted for any special circumstance (Rezat, 2009). It is important that the structure of the mathematics textbook should be adapted to address the target audience constructively (Valverde et al., 2002), so that the learners can identify with the content and become the authors of their own learning experiences (Sujee, in print). In this chapter, I aim to discover, from the existing literature, to what extent the mathematics textbook is still a useful resource and how it needs to be adapted to address the context of the UAE.

2.2. Textbook use in the international mathematics classroom

In 1984, Churchouse, Cornu, Ershov, Howson, Kahane and Van Lint established that, with the introduction of more technology into the classroom, the previous "dual relationship" between teacher and learner was transformed into a triangular "learner-teacher-computer" relationship. Yet Rezat (2009) argues that this conceptualisation disregards the importance of the textbook and that the relationship between teacher and learners has never, in fact, been just dual. Indeed, the mathematics textbook was, and still is, considered to be one of the more important tools in this context. Despite the obvious attraction and powers of innovation, technology and new tools in the classroom, Howson (1995:32) argues that it should be accepted that technology's importance and role "pales into significance" when it is compared with written materials like textbooks. Educational resources have, however, come a long way since Howson made this statement in 1995 and this statement is disputed in most literature reviews after 2009 (Rezat, 2009; Swanepoel, 2010; Wen-Cheng, 2010; Alzahrani, 2014).

Technological advances, the birth of YouTube in 2005 and even smartphones have had an immense, positive effect on classroom resources (Al Falasi, 2004; Norris, 2012) and technology trumps traditional textbooks in the "first world classroom" (Parrish, 2004:41), a cause for reflection when conducting research on adapting a textbook.

Controversy arises when trying to define a "first world classroom" (Mohammad & Kumari, 2007). In their paper on textbook use in Pakistan, Mohammad and Kumari (2007) attempt to draw parameters around and comparisons between classrooms in developed and developing countries. While some researchers (Howson, 1995; Rezat, 2009) make use of a primitive distinction based on average income per household, others (Norris, 2012; Alzahrani, 2014) reason that life expectancy and access to basic resources should also play a vital role. For the purpose of my research, I will side with Wen-Cheng (2010) who describes the classroom in a developing country as one where the primary language of instruction is not the same as the language most widely spoken by the learners. Most developed countries employ English as the medium of instruction (Rezat, 2009), while this is not the case in developing countries (Snyder, 2014). This means that most online resources are adequate and effective as teaching resources for both teacher and learner in developed countries (Mohammad & Kumari, 2007).

YouTube videos, social media groups and even electronic textbooks and worksheets are welcomed and widely used in countries where English is understood by most learners in the classroom (Haggarty, 2001; Wen-Cheng, 2010). In these countries the textbook is no longer respected as much, as Howson pointed out in 1995, but cannot be dismissed in its entirety (Rezat, 2009; Norris, 2012; Wen-Cheng, 2010).

It is in developing countries that textbooks still play a vital role in education (Rezat, 2009). Haggarty (2001) states that in developing countries, the mathematics textbook is the primary curriculum and teachers use it for most of their planning. Snyder (2014) adds that in developing countries, the textbook is often the only resource available to students to study from at home, since technology is either unavailable or cannot be understood. Moreover, while technology may be available in developing countries, the resources may not be available in a language that is understood (Mohammad & Kumari, 2007). In a developing classroom, textbooks not only provide teachers with guidance when planning lessons, they also ensure structure, consistency and logical progression (Wen-Cheng, 2010). Teachers firstly use textbooks to plan and prepare lessons, then they use them to mediate the mathematical content for the learners and, finally, learners learn from the textbook (Rezat, 2009). Johansson (2006), supported by researchers like Ghamri (2012), Henning (1996), Wen-Cheng (2010) and Haggarty (2001), argues that it is in mathematics classrooms in developing countries in particular that the textbooks' worth is invaluable.

It is important to note that the use of textbooks in isolation should not be accepted (Love & Pimm, 1996) and teacher intervention, student participation and a more varied spectrum of resources are required to maintain a diverse and holistic education system (Mohamed & Kumari, 2007). In developing countries, the responsibility of education, however, falls strongly on textbooks (Shellard & Moyer, 2002) and therefore it is imperative that teachers adapt the content to make it more relevant for learners (Wen-Cheng, 2010). This is a time-consuming process and a general complaint voiced by teachers in developing countries (Snyder, 2014).

While some argue that mathematics is just about numbers, research shows that mathematics has a language of its own (Johansson, 2006; Haggarty, 2001; Ghamri, 2012). The language of mathematics cannot, however, be taught if the medium of instruction is not understood (Snyder, 2014; Henning, 1996; Shellard & Moyer, 2002). Mathematical problems cannot be deciphered, understood, comprehended or made a learner's own (Shellard & Moyer, 2002) unless there is a basis on which to build this knowledge (Henning, 1996). Griffiths and Clyne (1994) point out that the language used in a mathematics classroom differs significantly from learners' everyday language and this is one of the most basic reasons children find mathematics difficult. Although the teacher needs to contextualise the vocabulary (Ghamri, 2012), a textbook can provide a primary guide for learners when the teacher is not around (Griffiths & Clyne, 1994; Shellard & Moyer, 2002; Haggarty, 2001).

Three critical components of effective mathematics teaching have been identified by Shellard and Moyer (2002), namely, teaching for conceptual understanding, developing children's procedural literacy, and promoting strategic competence through meaningful problem-solving investigations. These components should be addressed in the textbooks in such a way that learners are motivated to learn through the use of relevant examples that they can relate to (Alzahrani, 2014). Since no two classes will are exactly the same (Henning, 1996), each will have its own range of abilities and, since the publishers of mathematics textbooks do not enter every classroom (Haylock, 1991), such textbooks cannot always accommodate learners' special problems or exceptional abilities (Henning, 1996). Nevertheless, textbooks still form the basis of most teaching (Haggarty, 2001) and teachers should know not to use the textbook as a single resource (Rezat, 2009) but as a supplement to teaching content (Henning, 1996).

The perfect mathematics textbook is linguistically adapted to suit the literacy levels of the students (Wen-Cheng, 2010; Johansson, 2006), translations are available for additional

language learners (Mohammad & Kumari, 2007), examples are made relevant to their environmental and social context (Ahmed, 2010), and exercises are scaffolded with levels that can be attained by low ability to high ability students (Johansson, 2006; Ghamri, 2012; Swanepoel, 2010). Wellington and Osborne (2001:4–5) highlight four important factors when searching for the "perfect" textbook: the language in the textbooks should be read by learners with understanding; learners should be guided to write in logical and coherent forms relating to the subject; textbooks should provide sufficient support for learners to understand the vocabulary associated with the subject; and the appropriate jargon relating to the subject content should be explained. Although a perfect textbook should be idealised, it will never truly be acquired, as the scenery of the education field is ever-changing (Apple, 1986; Haggarty, 1991; Henning, 1996; Ghamri, 2012). This should not be seen as a hindrance but rather as a positive effect on educating the next generation (Johansson, 2006; Wellington & Osborne, 2001; Haggarty, 1991; Swanepoel, 2010).

Even the sceptics on textbooks use cannot deny that they have an significant role to play in mathematics teaching (Haggarty, 2001), especially in developing countries (Wen-Cheng, 2010). Textbooks ensure that teachers do not waste time when planning (Snyder, 2014), that the most basic content will be covered during every academic year (*New School Model*, c.2009) and that learners have some form of support at home (Griffiths & Clyne, 1994). Even though textbooks are not autonomous and should not be used in isolation (Henning, 1996), they form a fundamental part of mathematics teaching and learning (Johansson, 2006).

2.3. The United Arab Emirates: a contextual perspective

When the UAE was established in 1971, education opportunities were "extremely limited" (*Sharjah ruler supports establishment of "Arabic Tongue Council" in Nouakchott*, 2017:1). Since the establishment of the federation, the UAE has introduced programmes aimed at ensuring female equality in education (Tabari, 2014), focusing on improving literacy levels (Khalaf, 2009) and implementing modern curricula (*New Schools Model*, c.2009). Currently, 25% of total government funding is directed towards education (*Schools in the UAE*, c.2009 & *Social Statistics: Education*, 2017), making the UAE a world leader in education spending, with more than 1,1 billion AED being spent in Dubai alone (Langton, 2017).

In 2007, the Ministry of Education (MoE) adopted "Education 2020" in terms of which mathematics and science were integrated as core subjects from first-grade levels in 2008

(*Reports and statistics*, n.d.). Since the UAE government believes that low literacy levels and a poor grasp of English is one of the main barriers to employment, much attention has been focused on the teaching of English in schools (Alzahrani, 2014). In 2008, the MoE (*Reports and statistics*, n.d.) launched the Mentoring Programme, thus assigning 50 Western principals to 735 public schools across the UAE. This lead to the realisation that more international schools were needed to educate not only the locals but also the children of expatriates (Tabari, 2014):

> Abu Dhabi emirate currently has around 185 private schools operating in three regions; Abu Dhabi, Al Ain, and the Western Region. The Private Schools & Quality Assurance Sector caters for approximately 200,000 learners of different nationalities including the 50,000 Emirati learners which is 25% of the total number of learners registered in private schools. With such a large learner population, the development of a quality private education system is a crucial foundation required to help achieve Abu Dhabi's Economic Vision for 2030 (*Social Statistics: Education*,2017:2).

Although education in the UAE has come a long way, there is a "deep awareness that much more needs to be done" (*Sharjah ruler supports establishment of "Arabic Tongue Council" in Nouakchott*, 2017:2).

The academic year starting September 2017 saw unexpected changes in education governance in the UAE (Langton, 2017). A new educational system, on Sunday 3 September 2017, the Emirati School Model (ESM) was announced, which is aimed at unifying the education sector across the UAE and raising standards of teaching and learning (Zaman, 2017). Shaikh Mohammad Bin Rashid, the ruling president of the UAE, stated that "the main goal is to enable all schools across the country to operate under a standardised framework that is developed on the best international practices" (Zaman, 2017:1). During the announcement, Hussain Ebrahim Al Hammadi, Minister of Education, said: "Our students are the most important resource of the UAE. As leaders, we have an obligation to provide them with a modern international education, and the Emirati School Model matches this ambition and future plans of the UAE" (Langton, 2017).

Dr Ali Al Nuaimi, Director-General of ADEC, stated that the decision to unify the system is harmony with the current phase of educational development (Zaman, 2017) and called on

teaching and administrative staff to participate in developing promising and innovative generations that are enriched with high quality education and culture (Langton, 2017). Al Nuaimi urged educators to contribute to building the character of pupils (Masudi, 2017).

The unification of ADEC and the Ministry of Education merges the two authorities into a new system (Zaman, 2017). The alignment plan consolidates the ministry's systems, policies and courses across UAE public schools as well as private schools using the MoE curriculum (Langton, 2017; Zaman, 2017). The MoE and ADEC have formed two main committees working towards the development of the school community (Langton, 2017). These committees will support and enable teachers to fulfil their responsibilities and establish new rules for the integration of ADEC and the MoE (Masudi, 2017).

Under the new system, government schools and some private schools will follow the same curriculum, which will focus on building critical thinking skills and developing innovation and teamwork among students, in addition to utilising information technology in problem solving. Mathematics and science, in conjunction with English, will take the lead as core subjects. The aim is to unify the education systems and policies, as well as learning paths in all government schools and private schools following the ministry system (Masudi, 2017; Zaman, 2017; Langton, 2017). The remainder of the private schools are permitted to follow their original curriculum path if they so wish (Masudi, 2017).

The UAE will also welcome around ten new private schools in Dubai and seven in Abu Dhabi, offering British, Indian, International Baccalaureate (IB), French, Canadian, American and UAE curricula (Masudi, 2017). The academic year 2017/2018 will see more than 1,1 million students in the UAE (*Social Statistics: Education*, 2017:2). This system is still in the transitioning phase and the new official policies are still awaited by managers (Langton, 2017). On 10 September 2017, new textbooks were delivered to all government schools replacing previous textbooks. These changes did not, however, affect the private sector where the British curriculum is mainly followed. Although Moral Education is now a compulsory additional subject in all private schools (Masudi, 2017) and some changes have been made to the structure of sciences and social studies (Langton, 2017), mathematics remains unchanged (Zaman, 2017). In my mathematics classroom the only change that has occurred is that the time allocated per week per year group has been reduced by an hour.

Tabari (2014) highlights three main challenges facing the education system in the UAE: unclear goals, also related to discrepancies in the curricula, inappropriate methods of teaching and learning and an inflexible curricula. These issues have been attributed to the preservation of traditions and cultures in the UAE and concerns raised about the global spread of English (Ahmed, 2010). English literacy may be improving theoretically but in the real-world classroom, learners are still struggling (Tabari, 2014). When the textbook fails to guide learners, they simply give up on learning the content (Khalaf, 2009) and this constrains not only their progress in English but also the subject being taught (Rosenthal, 2016).

The UAE is considered a developed country (United Nations, 2005), with economic status ranking among the top in the world (Tabari, 2014; Khalaf, 2009). Despite one of the highest educational budgets in the world (Ahmed, 2010), however, a few aspects of the education system have been neglected (Tabari, 2014; Alzahrani, 2014), including learners' English literacy levels. According to Ghamri (2012), the UAE regards linguistic ability simply as being able to converse in English, with the correct grammar being used and a reasonable reading ability. The overall expectancy of learners, as set by the MoE, is "unrealistic" and "worlds away" from the real literacy levels being maintained in schools in the UAE (Tabari, 2014:23; Ghamri, 2012:12).

Wen-Cheng (2010) describes the notion of a developing classroom as one where the language of instruction differs from the language understood by most learners, thus implying that it is possible to have a developing classroom within a developed country. Ghamri (2012) agrees with this challenge when referring specifically to classrooms in the UAE. The UAE may be economically strong, socially stable and developmentally on par (Ahmed, 2010; Khalaf, 2009; Ghamri, 2012) but the average classroom is "still lacking sufficient progress" (Alzahrani, 2014:19).

The UAE is a conservative country built on the religion of Islam, where strong social rules govern the everyday life of residents (Tabari, 2014). Such moral conduct influences the education sector, challenging educators on a different level (Ahmed, 2010). Part of the new ESM, implemented in 2017, consists of Moral Education (ME), a new subject introduced where topics like respect, benevolence and socially accepted behaviour are addressed (Langton, 2017). The education system has been subjected to socially conservative rules since 2005 (Tabari, 2014) with teachers being required to wear specific attire, certain topics are forbidden

in classrooms and strict rules regarding the safeguarding of children apply (Ghamri, 2012; Snyder, 2014). When considering the social context of the UAE and the fact that the textbook is the only guidance teachers have in terms of curriculum, it is unclear why textbooks have not been specifically adapted for use in the UAE (Snyder, 2014; Ahmed, 2010; Alzahrani, 2014; Tabari, 2014).

Valverde et al. (2002) argue that the structure and layout of textbooks embody a specific pedagogical model and thus advance a specific plan for the educational success of a lesson. Pearson Education urges teachers to "choose books that fit your specific needs" (*Reports and statistics*, n.d.:1) and Alzahrani (2014) states that the textbook is a basic source of information in the educational process. Although many studies have been done on the importance of textbooks in class (Apple, 1986; Haggarty, 1991; Alzahrani, 2014; Tabari, 2014; Johansson, 2006; Snyder, 2014) there is a vast lacuna when it comes to textbooks in the UAE (Snyder, 2014).

In June 2009, Dr Mugheer al Khaili, the director general of ADEC stated :

> We want to have bilingual learners, which still means that we must preserve our culture and religion and maintain the importance of the Arabic language but we also need to concentrate on English ... it is the international language of instruction, the language of science, business and technology (Khalaf, 2009:43).

This has resulted in classrooms where educators teach in English but learners do not have a sufficiently high literacy levels to understand what is being taught (Ahmed, 2010). The textbooks thus become "bookshelved" (Snyder, 2014:2) owing to the learners' inability to read English and teachers feel unmotivated when they cannot use the examples and exercises these textbooks contain (Johansson, 2006).

In both government and private schools in the UAE, textbooks are still the primary resource (Snyder, 2014; Ahmed, 2010; Khalaf, 2009). Hence, these textbooks needed to be adapted for more effective teaching (Snyder, 2014). Accordingly, a continuous effort to produce suitable resources will lead to a more established education system in the UAE (Musadi, 2017). This accentuates the relevance of my research in the UAE setting in terms of the way the contextual adaptation of a textbook will improve the quality of the resources used and have a positive effect on the learning of mathematics specifically.

2.4. British mathematics textbooks in international schools in Abu Dhabi

Although only a small percentage of learners will follow a mathematical career path, education aims to equip every learner with at least a basic knowledge and understanding of mathematics (Swanepoel, 2010; Lederman, 2008). The UAE is no exception. Since the country's education reform began in 2005 (Khalaf, 2009), a great deal of emphasis has been placed on the teaching of mathematics and science in both public and private schools (Ahmed, 2010). While the curriculum for mathematics in public schools is currently being rewritten by the new Ministry of Education and Knowledge (Langton, 2017), the private schools continue to follow their original curriculum. Currently, 48 of the 185 private schools in Abu Dhabi follow a British curriculum (*Schools in the UAE*, n.d.). Only 28 of these British schools cater for secondary learners, also known as Key Stage 3 and Key Stage 4 in the British schooling system (*British Council in the UAE*, 2017). Mathematics is one of the core subjects of the British curriculum and in all 28 British secondary schools in Abu Dhabi, mathematics is compulsory until the end of Year 11 (*Schools in the UAE,* n.d.).

At the end of Year 11, students are required to write a standardised examination, called the IGCSE (International General Certificate of Secondary Education). This exam is set by the British Education Council and no literacy or contextual adjustments are made to accommodate international students (Ahmed, 2010; *British Council in the UAE*, 2017). It is therefore imperative that the students are prepared for this exam in the correct manner, throughout Key Stage 4 (Years 10–11) so that they are not left behind (Ahmed, 2010; Khalaf, 2009). If the textbook can comply with learners' literacy levels and be useful within their context, while conveying the necessary content, the textbook would be an optimally successful and effective resource (Ahmed, 2010; Tabari, 2014; Snyder, 2014). Since mathematics has a language of its own (Crawford, 2003, Johansson, 2006; Shellard & Moyer, 2012; Davis, 2009), concepts first need to be simplified for understanding and then adapted to prepare learners for the final examination (Al Falasi, 2004; Alzahrani, 2014; Crawford, 2003). The best point of departure for teaching in a developing classroom is the textbook (Wen-Cheng, 2010) and the UAE is no exception (Khalaf, 2009).

Textbooks have many positive characteristics that are of benefit to education, as Wilson (1997:6) points out. A "book is portable", often contains both text and graphics, making it a "multimedia object" that is "conveniently accessible", and the "energy demands are minimal". The relationship between learner achievement and the availability and utilisation of high-

quality textbooks is well researched and established (Ogan-Bekiroglu, 2007) and the use of well-designed textbooks can have a positive effect on the implementation of the mathematics curriculum (Davis, 2009). In the technological era, the textbook is often overlooked as a resource, but in developing classrooms the textbook is still referred to frequently and its presence is non-negotiable (Davis, 2009; Wen-Cheng, 2010; Oates, 2014; Khalaf, 2009). Textbooks are primarily used by teachers for planning lessons, as textbooks guide them in terms of the curriculum content (Crawford, 2003; Davis, 2009; Shellard & Moyer, 2002).

While experienced teachers can perform well without the use of any textbook (Swanepoel, 2010), the textbook is a crucial resource for an inexperienced or under-qualified teacher (Davis, 2009; Crawford, 2003; Dowling, 1996). An aptly qualified and experienced teacher will access the textbook and make the adaptations required to fully unlock the learners' potential (Tyson, 1997; Swanepoel, 2010). This is especially true if the teacher has been teaching continuously in the same school for more than three years (Crawford, 2003). Teachers specialised in specific subject areas might not be confident in different curricula (Oates, 2014), for example a teacher trained to teach mathematics for years 7–9 might not be equally confident in the British and IB curriculum. The importance of the textbook is exponentially higher for the beginner teacher with little experience, as they often use the textbook as personal guidance for implementing the curriculum (Ogan-Bekiroglu, 2007), not looking at the context of the teaching holistically but focusing on conveying only the knowledge as set out by the curriculum (Tyson, 1997; Al Falasi, 2004; Swanepoel, 2010).

The teaching staff in the UAE constitute a unique blend of nationalities and experience (Al Falasi, 2004). More than 60% of teachers in schools are younger than 28 years old, making the private education sector in Abu Dhabi "fairly inexperienced" (Abosalem, 2016:33). In the British schools in Abu Dhabi, the average teaching experience of a teacher is less than four years and the average duration of employment is two years (*British Council in the UAE*, 2017). Al Falasi (2004) states that the shorter contracts in the UAE means that the staff turnover is extremely high and this has an influence on the overall experience of teachers teaching in that country. Almost all employment in the UAE is offered in the form of two-year contracts (Abosalem, 2016), resulting in teaching staff being continuously inexperienced in the UAE context (Al Falasi, 2014). Even the older, more experienced teachers are not necessarily very familiar with the curriculum they teach, making them inexperienced from a different perspective (Ghamri, 2012; Abosalem, 2016). British schools aim to employ at least 40% of

British teachers, who are familiar with the curriculum, but this is not a realistic goal and very often the demography of a British school will be cosmopolitan and international in nature (*British Council in the UAE*, 2017). When taking these considerations into account, the necessity for textbooks in schools in the UAE can be highlighted as high priority, relevance and need (Swanepoel, 2010; Abosalem, 2016; Ghamri, 2012; Oates, 2014).

Haylock (1991) mentions that the textbook may be the first place a learner with low achievement in mathematics will go to for assistance and if the guidance cannot be found there, the possibility is great that the learner will simply give up. Oates (2014) raises the question of digital engagement in the mathematics class, explaining that even though social media and digital resources are used with great success in developed classrooms, this success is not ultimately a death sentence for the textbook. Textbooks have been refined with years and years of research and knowledge, while digital materials are still being developed to reach their potential. While blended learning holds promise, the textbook cannot be disregarded in the classroom "yet" (Oates, 2014:5–6). Wen-Cheng (2010) argues that digital resources are not yet sufficient to replace textbooks in developing classrooms and Mohammad and Kumari (2007) add that textbooks are still the most tangible resource a learner can use.

Abosalem's (2016) research on textbook use in the mathematics classroom in Abu Dhabi has shown that learners prefer textbooks to photocopied notes and that textbooks are used by learners up to 27% more than any other mathematical resource. Learners who do not speak English at home, often cannot look to their parents for help, as the parents are not English literate (Alzahrani, 2014); the textbook then become their only source of possible knowledge (Ghamri, 2012; Abosalem, 2016; Alzahrani, 2014).

The mathematics textbooks used in British schools are imported from the UK (*British Council in the UAE*, 2017) and are used without any amendments in the UAE (Snyder, 2014). The problem of literacy levels in the UAE has been identified by various researchers (Al Falasi, 2004; Ghamri, 2012; Abosalem, 2016; Ahmed, 2010; Alzahrani, 2014; Tabari, 2014) and this often makes the textbooks an ineffective and impractical resource in classrooms, as they have not been adapted for a lower understanding of English (Snyder, 2014).

A good quality textbook is defined by Bernier (1996:284) as the "congruence between the desired learning outcomes as specified … and the actual learning outcomes achieved". An

effective textbook should fulfil the needs of the teacher (Swanepoel, 2010) and guide the student to achieve the lesson outcome in an understandable and contextualised way (Bernier, 1996; Swanepoel, 2010; Khalaf, 2009). Oates (2014) emphasises the importance of curriculum coherence, as well as the fact that knowledge-rich and suitable textbooks can address the issue of teacher workload. Al Falasi (2004) found that teachers in the UAE are irritated by the literacy levels in textbooks and Ahmed (2010) argues that most textbooks are not suitable for use in UAE classrooms. The British schools in the UAE should deliver the same content (*Social Statistics: Education* 2017; *British Council in the UAE*, 2017) to learners with much lower literacy ability (Ahmed, 2010), a vastly different context and culture compared to the United Kingdom (Snyder, 2014), all while using the same textbooks that are used in the UK (*Social Statistics: Education*, 2017; *British Council in the UAE*, 2017).

Even and Schwarz (2002) recognise that the focus of mathematics education research has been extended from learners' individual cognition and knowledge, to contextual, socio-cultural and situated aspects of mathematics learning. This is of importance when considering that the UAE has many different teachings and contexts to take into account when planning a curriculum (Tabari 2014; Ahmed, 2010). While a plethora of research has-been concentrated on second-language development and learner educational achievement (Ghamri, 2012), a lot less has focused on the literacy levels and social context in mathematics classrooms (Al Falasi, 2004).

Carrow (1957) was one of the first researchers to recognise that cognitive competency is often overruled by language barriers. In Abu Dhabi, only about 9% of all enrolled learners in British international schools speak English as a home language (*Social Statistics: Education*, 2017). This implies that textbooks used in British schools are often not understood by learners (Snyder 2014) and the social context of their direct environment and surroundings not taken into consideration (Al Falasi, 2004). With some effort and research, the UAE could adapt mathematics textbooks for use in the British schools so that they may be better understood by learners and more effectively used by teachers, as well as better preparing students conceptually for the final examinations.

As Swanepoel (2010:5) states: "The most powerful and direct way to draw forth better textbooks is to create and sustain a well-funded, unhurried, and thoughtful system of textbook evaluation." This accordingly relates to the aim of my research.

2.5. Conceptual framework

2.5.1. Multiliteracies in textbooks

As society develops and changes, so do the needs of learners. Education sectors have been forced to leave literacy as a single entity behind and embark on a journey of discovering many literacies (Engelbrecht & Hugo, in print). In 1996, the NLG gave birth to the idea of multiliteracies (Roswell et al., 2008; Bond, 2000; O'Byrne & Smith, 2015) as a response to the exclusion of non-mainstream learners in schools (Engelbrecht & Hugo, in print). They described this as "a new approach to literacy pedagogy" (NLG, 1996:12).

Multiliteracies as a pedagogical approach highlights two fundamental principles of literacy, namely, linguistic diversity and multimodal forms of linguistic expression (Cope & Kalantzis, 2009; Anstey & Bull, 2006). As communication developed through the use of technology, an improved method for teaching literacy evolved and so the term *multiliteracies* was coined (Selber, 2009; Cope & Kalantzis, 2003). The last few decades have seen an increase in transnational migration patterns and thus communication has become more complex. This migration has had a significant effect on the education system (Roswell et al., 2008; Bond, 2000; Cope & Kalantzis, 2015). Even where the primary medium of instruction is English, the variants and dialects from all over the world emphasise the need for a more diverse and applicable method for literacy teaching. Accordingly, multiliteracies was the solution provided by the NLG (1996) (Jewitt, 2014; Pahl & Roswell, 2013; Cope & Kalantzis, 2009).

The pedagogy of multiliteracies expands the primitive definition of literacy as reading, writing and speaking into a vast and more extensive multimodal discourse of literacy domains (Roswell et al., 2008). Originally developed to allow for more inclusivity in schools (Selber, 2009), multiliteracies transformed into a linguistically diverse paradigm (Bond, 2000; Jewitt, 2014), allowing modern students to grasp literacies in terms of language, technology, culture, context and even visual aids (Cope & Kalantzis, 2015). Jewitt (2014) describes multiliteracies as a scholar who deals with meaning-making processes in various ways, using a variety of resources. The NLG (1996) noted many varying forms of literacy, including the language of sciences and mathematics.

While mathematical literacy encompasses certain concepts, principles and skills that have to be acknowledged before a learner can gain mathematical knowledge (Haylock, 1991), multiliteracies highlights that these mathematical concepts may not only be learnt via language

but also that other methods and media can be applied in the process (Cope & Kalantzis, 2009; Selber, 2009). Another process that is highlighted by multiliteracies is that students need to draw more on their own experiences in order to acquire new knowledge (Selber, 2009) and that there is more than one vehicle to use in order to arrive at the final destination of this new knowledge (Cope & Kalantzis, 2015).

Crawford (2003) suggests that textbooks need a multimodal approach to fully lead the learners and teacher towards successful learning and that different forms of literacy need to be understood. Johansson (2006) suggests that in order for mathematics textbooks to be used with greater effectiveness not only is adaptation required, but a teacher should also be able to transcribe the written text into more meaningful constructs in the classroom. Multiliteracies employs not only written words and visual aids in textbooks but also challenges educators to think innovatively and in the realm of the learner's perspective to convey the concepts described (NLG, 1996; Jewitt, 2014; Cope & Kalantzis, 2009).

When understanding that multiliteracies is an extension of society (Cope & Kalantzis, 2003) one can draw the parallel between critical theory and multiliteracies, as literacy is one of the most primary social skills one can acquire (Jewitt, 2014). As the NLG (1996) urged, education should move away from a singular literacy, whether it be oral or written, to a better understanding of cultural and linguistic diversity. In the UAE, cultural diversity and language literacy levels hinder academic progress (Khalaf, 2009), especially when depending solely on the textbook as a monoliteracy; thus, multiliteracies will broaden the understanding of the required adaptions to be made.

Multiliteracies rests on the four pillars set out by the NLG (1996), namely, overt instruction, situated practice, critical framing and transformed practice. Roswell et al. (2008) refer to overt instruction as the teacher's active intervention in adapting multiliteracies to a practical entity in the classroom, where learners can make textbook content a reality in their own world. The original formulation by the NLG (1996) includes educators supporting learners by focusing on the important features of their experiences and activities within the community of learners (Cope & Kalantzis, 2003). Overt instruction is often misrepresented as direct transmission, drills and teacher instruction, without interference by learners (O'Byrne & Roswell, 2015; Jewitt, 2014). On the contrary, during the process of learners remodelling their known world

by making "cognitive links between the abstract and the concrete during the process of learning" (Genis, in print:3), reality is conceptualised and new knowledge acquired.

In situated practice, the active teacher links the learner's pre-knowledge and own experiences to new knowledge (Cope & Kalantzis, 2003; Engelbrecht & Hugo, in print). Involving real-world contexts and taking into account the affective and sociocultural needs of learners, Cope and Kalantzis (2009:184) reframed this as "experiencing" knowledge. Believing that human cognition is contextual (Cope & Kalantzis, 2003) and meanings are grounded in the reality the learner live in (Roswell et al., 2008), subjective interest will spark inspiring learning methodologies (Selber, 2009).

Cope and Kalantzis (2015) argue that learners can learn from each other by sharing their personal experiences as well as by being immersed in new situations and experiencing the new knowledge personally. Situated practice should not be applied in isolation (NLG, 1996) as learners are not always consciously aware of what they are learning and how they are progressing (Cope & Kalantzis, 2015). When subjectively involved in your own learning, it is easy to stray from relevance to historical, political, cultural or ideological relations (Cope & Kalantzis, 2015; Jewitt, 2014). This is exactly why the NLG (1996) urges that situated practice needs to be supplemented with more multimodal literacies.

Critical framing has relevance to my research as it emphasises the symbiotic relationship between written text and social context (Jewitt, 2014) and all changes are made with equal opportunity and fairness in mind (Engelbrecht & Hugo, in print). Critical framing requires an investigation of the socio-cultural contexts and purposes of learning and designs of meaning (O'Byrne & Smith, 2015). The UAE is a cosmopolitan country with increasingly diverse and globally interconnected lives and where the forces of migration, multiculturalism and global economic integration have intensified the processes of change, all contributing factors in the critical framing in multiliteracies (Khalaf, 2009; Ahmed, 2010; Cope & Kalantzis, 2003).

Within critical framing, learners and educators are encouraged to go beyond cultural influences and gain new knowledge in new formats, including digital media and literature previously seen as inferior to traditional texts (Ansley & Bull, 2006; Cope & Kalantzis, 2009). Jewitt (2014), Cope and Kalantzis (2009) and Pahl and Roswell (2013) argue that being oversensitive towards learners' frames of reference causes them to lose out on potential learning curves in society

and that electronic media, technological forums and online communities should not be ignored or deemed irrelevant in the quest for new knowledge. Multiliteracies wants us to think beyond conventional resources and texts and find what is most relevant to the learners in order to maximise teaching potential (Cope & Kalantzis, 2015).

According to Engelbrecht and Hugo (in print), transformed practice relies on innovation and creativity in the classroom, where learners transform their own learning into something recognisable. Embedded in authentic learning, where activities are recreated to suit the real-world context of learners, the "theory becomes reflective practice" (NLG, 1996:87). Cope and Kalantzis (2015) explain that transformed practice implies applying new knowledge to real-life situations, where learners then have the opportunity to see if it is true or not. According to Selber (2009), teacher guidance has a substantial influence on transformed practice but the results can be worth the planning.

When working from and with a textbook (or multiple textbooks) in a mathematics classroom, one should not adhere to one single literacy, namely, mathematics as a language (Crawford, 2003), as conceptualisation cannot reach its full potential if the textbook is the only resource (Khalaf, 2009). This is especially the case if the textbook is not adapted with the specific learner in mind (Snyder, 2014). The theoretical lens of multiliteracies provides ample and differentiated ways of supporting both teachers and learners (Jewitt, 2014) in the quest to become part of an effective global community (Roswell et al., 2008). The UAE education system is unique in the sense that it is regulated by religious boundaries (Ahmed, 2010) as well as being diversified and young (Tabari, 2014). To adapt and change the content, the social context portrayed and the literacy levels in the prescribed textbooks, the researched phenomenon should be examined through the lens of multiliteracies, bearing in mind the contribution this theory can make to this research problem.

2.5.2. Critical theory

Critical theory draws strongly on a social reality as a “construction process” (Nieuwenhuis, 2016:63), while the theory of multiliteracies stems from the changes made in society (Engelbrecht & Hugo, in print), ensuring that these two frameworks will strengthen and complement each other when working in the social realm. My research will benefit from both of these frameworks, particularly because I will also be using a critical paradigm and a CDA, which will be discussed in Chapter 3.

According to Blaikie (2000:135), reasoning is the "highest potential of human beings" and when we explore the nature and coherence of existing societies, we may challenge the negatives in search of more positive outcomes. Critical theory is grounded in the idea that with application of knowledge from the humanities and the social sciences, society can assessed by reflecting on the culture of that society (Horkheimer, 1993; Cohen et al., 2007). Critical theorists maintain that ideology is the principal obstacle to human liberation (Bohman, 1991) and maintain that research is conducted for "the emancipation of individuals or groups in an egalitarian society (Cohen et al., 2007:26).

Critical theory stems from the Greek word *kritikos*, which may be translated as "judgement" or "discernment" and was first defined by Horkheimer in 1937 in his essay "Traditional and Critical Theory" (Horkheimer, 1993:21): "critical theory is a social theory oriented toward critiquing and changing society as a whole, in contrast to traditional theory oriented only to understanding or explaining it." According to Nieuwenhuis (2016:64), the "critical educational researcher aims not only to understand or give an account of behaviours in societies but to change these behaviours".

Hesse-Biber and Leavy (2011) highlight that critical theory should look at society in its entirety, while not disregarding the history of the social environment (Horkheimer, 1993), in order to understand how the society came to be configured at a specific point in time (Cohen et al., 2007). A second underpinning of critical theory is that it aims not only to understand but also to improve society by integrating all relevant factors, including psychology, economics, politics, anthropology, geography and sociology, into the research (Nieuwenhuis, 2016; Horkheimer, 1993; Bohman, 1991; Blaikie, 2007). Horkheimer (1993:12) summarises critical theorists' point of view on society: "The point is not only to understand but to change society for the better."

When reading Oates' (2014:12) description of an ideal textbook, "the learners should not only understand the content but also be able to change it", one can draw a parallel between critical theory and textbooks. Teachers should not only use the textbook to provide content but should also aim at improving the content by changing it to better suit the learners' needs (Ahmed, 2010; Henning, 1996; Abosalem, 2016; Rezat, 2009).

Although critical theory assumes that social reality is created in history (Nieuwenhuis, 2016), critical researchers will always seek to transform this reality into something better (Horkheimer, 1993). This links well with multiliteracies, since multiliteracies claims to develop literacy without erasing the cultural or social identity of the people involved (Engelbrecht & Hugo, in print). Johansson (2006) and Oates (2014) agree that textbooks are considered social artefacts and that the history of a society can be seen between the pages of textbooks.

Henning (1996) states that even in mathematics textbooks the social and political changes of society can be depicted and Rezat (2009) urges teachers to be aware of the social agenda that textbooks might have, however small it might be. The textbooks used in mathematics classrooms in private schools in Abu Dhabi have no relation to the history or social context of the UAE, but adapting them to consider this would empower teachers and learners alike (Snyder, 2014; Mohammed & Kumari, 2014; Abosalem, 2016).

2.6. Conclusion

There is a vast amount of literature available on textbooks, the use of textbooks in the mathematics classroom and even suggestions on how to adapt textbooks for EAL learners. However, while the last few years have seen some research being done on Arabic schools and the implementation of English in these schools, in all subjects across the curriculum, the literature is silent when it comes to private international schools in expatriate communities like Abu Dhabi.

Although textbooks are specifically written for the government schools, the textbooks used in international schools are imported so that no curriculum content is lost. Unfortunately, the literacy levels and social contexts of the learners often make the content too difficult for them to understand and all the responsibility of making the content relatable shifts to the teachers. When considering that more than half of the teachers are fairly inexperienced and new to the UAE, it is understandable that teachers struggle and often feel discouraged and unmotivated.

Learners in private schools are excited to learn and while they want to achieve an international qualification, the textbooks are simply not a workable resource. When dealing with topics such as weather patterns, money matters and measurement that learners do not know the meaning of, contextual issues arise. The literacy in textbooks has not been adapted for EAL classrooms and no other form of literacy is employed to cover the content.

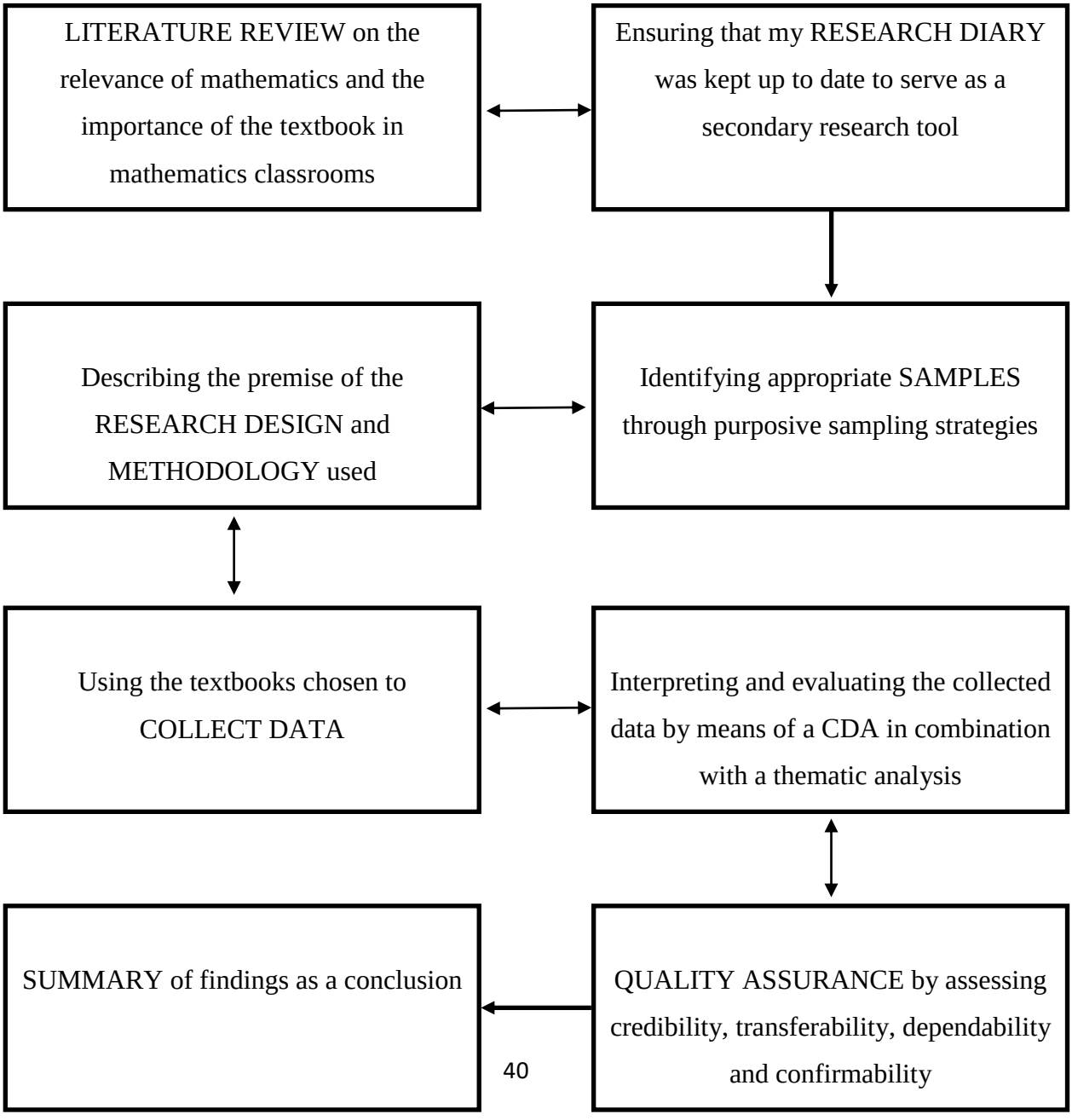
By looking at the situation critically, bearing in mind multiliteracies as a possible solution, the textbook in the mathematics classroom becomes a possible resource to get excited about. I consequently aim not only to understand the problem but also to bring about change, however small it might be.

CHAPTER 3: THE RESEARCH DESIGN

3.1. Introduction

In Chapter 2, as part of the literature review, the definitions and parameters were set as to why textbooks are still considered to play an important role in mathematics classrooms in the UAE. In this chapter I will describe the research process and the paradigmatic assumptions that guided my thought processes. This chapter will also expand on the research design I followed, the methodologies I applied and how the data were captured and analysed. The ethical considerations and quality control measurements will also be explained. Figure 3.1 is a visual representation of the research process.

Figure 3.1 Diagrammatic presentation of research process



3.2. Paradigmatic assumptions

A paradigm consists of the following components: ontology, epistemology, methodology and methods (Scotland, 2012). According to Nicholls (2001), the analysis of school textbooks involves identifying certain patterns and differences and registering comparisons. The philosophical underpinnings of research will determine the critical analysis of the data and it is therefore imperative that the paradigmatic assumptions are determined prior to the research (Maree, 2016) and used as a framework while the research is carried out. In the next section, the critical paradigm will be discussed.

3.2.1. The critical paradigm

In Chapter 1, I substantiated the decision to use CDA as my research design, implying that I would look at reality through the lens of the critical paradigm. The critical paradigm assumes that the ideological solution to most problems is camouflaged by realistic and practical power struggles and by social networks, including but not restricted to, political agendas, economic factors and influential individuals (Silverman, 2013; Patton, 2002; Giroux, 1988; Cohen et al., 2007; Creswell, 2013).

According to Bohman (2005), a critical paradigm may display similarities to interpretive and constructivist paradigms but it cannot produce a simple interpretation because possible solutions have to be explored. As my intention was to analyse the textbooks as well as to determine the extent to which the textbooks were unsuitable and eventually suggest possible solutions, the critical paradigm was well suited to my quest. Sandelowski (2010) and Jones (2006) add that the critical paradigm looks beyond economic and political factors, seeking equality in society rather than merely addressing power and influence.

The critical paradigm suggests that, in conjunction with critical theory, the current situation needs to be explained (Horkheimer, 1993; Bohman, 2005). Throughout the research process, using a CDA design and my research diary as a secondary research tool, I explained the misconceptions and gaps when using the current textbooks in the social context of the UAE. According to Guba and Lincoln (1994), Giroux (1988) and Scotland (2012), the critical paradigm should also identify the actions taken to change the current situation. My research diary is testament to the adaptations I had to make to almost every unit of the textbook in order to make the content a workable resource.

Horkheimer (1993) finally suggests that the research should provide clear norms for criticism and Nicholls (1993) adds that this is the reason why the critical researcher will not only explore the problem but also address possible transformations. With this in mind, the critical paradigm proved to be a very efficient lens for examining the textbook.

Critical research has an agenda for change (Scotland, 2012; Hawthorne, 2005) and therefore is often met with resistance by current political rulers (Blaikie, 2000; Jones, 2006; Scotland, 2012). According to Scotland (2012:1), "the critical paradigm exposes how political ideology is inextricably interwoven with knowledge". Education and the production of a society's knowledge is greatly influenced by political decision makers and often the critical paradigm is regarded with disfavour by existing policy makers (BonJour, 2002; Maree, 2016; Nicholls, 2003; Deetz, 1996; Sandelowski, 2010). In my research, the political agendas of policy makers were not the focus. Instead, I shifted the critical paradigm to the social dilemmas that I faced in my classroom and, when reflecting in my research diary, I could see the critical paradigm in action.

According to Blaikie (2000), social structures often tend to be more of a symbolic oppressor than the reigning political party. I concentrated on the agenda of changing the textbook in order to address the literacy levels and social context of the students in the classroom. It is important to note here, however, that even though politics was not a focal point, the students often seemed frustrated with the textbook in the educational context for various reasons. Having to prepare for an international examination, they had no choice but to omit certain topics, as the textbook did not give sufficient guidance in terms of literacy gaps or basic examples. Through the lens of the critical paradigm I can thus see the students as the ones that needed to be emancipated from the constraints posed by the textbook (Ritchie & Lewis, 2003).

Over the years, the critical paradigm has evolved into a more complex paradigm than the four traditional qualitative research paradigms (Kincheloe & McLaren, 2005; Guba & Lincoln, 1994; Deetz, 1996; Blaikie, 2000). When evaluating textbooks, I found that I sometimes contemplated a positivist or even a transactional paradigmatic assumption, but kept on coming back to the critical paradigm, as I felt strongly about pursuing the changes that would improve the current situation. This is exactly what Horkheimer (1993:6) and Guba and Lincoln (1994) report as a true critical paradigm when they note that critical feedback after research is the "start of constructive dialogue" and the beginning of "changes for the better".

In Table 3.1 I highlight five characteristics of the critical paradigm that are applicable to my research and summarise the way in which they guided me in perceiving the data.

Table 3.1: Principles of the critical paradigm applied

The critical paradigm	**Application to my own research**
The critical paradigm suits linguistic interpretation well (Deetz, 1996).	Since my research is of a qualitative nature and no numerical data were collected, the entire premise of my research is linguistic interpretation.
The critical paradigm challenges the guided assumptions of the social norm (Kincheloe & McLaren, 1994).	The textbooks are not prescribed but recommended by the British Education Council, as well as the British Schools in Abu Dhabi. As a teacher within this context, I experienced this social norm as unrealistic and thus challenged this "guided assumption".
The critical paradigm starts with what is good and moves towards the possibility of improvement (Giroux, 1988).	The textbooks are not impractical in totality, so I did not overlook the positive qualities of the textbooks, nor did I ignore the good intentions of the authors. Instead, I tried to focus on the possible improvements that could be made to ensure that the textbooks became a more valuable resource.
The critical paradigm is constantly trying to change the situation (Giroux, 1988; Guba & Lincoln, 1994).	Throughout my research diary it is evident that the content of the mathematics textbooks did not address all the social and linguistic needs of UAE learners. While analysing the data, I was constantly confronted with possibilities for the way the situation could be changed and improved.
The critical paradigm states that the truth can only be known or acquired through the raising of consciousness (Deetz, 1996; Creswell, 2007).	Since the UAE has a fairly young education system, the awareness of how the textbooks are lacking as a resource is still developing. Through my research I aimed to raise awareness of the matter.

3.2.2. Ontology

The generally accepted ontological position of the critical paradigm is historical realism (Scotland, 2012; Nicholls, 2003; Deetz, 1996). Historical realism stems from the view that reality has been shaped by social, political, cultural, economic, ethnic and gender values (Guba & Lincoln, 1994). Bubner (2003) argues that within the critical paradigm, the researcher might find that the characteristics of other ontological assumptions become evident. Nieuwenhuis (2016) maintains that most qualitative researchers who follow the critical route find their ontology in idealism.

After extensive reading on both realism and idealism, I still found myself gravitating towards idealism. I could understand that history had an influence on the reality and language in my classrooms but my main focus was still to create an ideal textbook to be used in the mathematics classroom. While the history and social context of the textbook could not be ignored (Ahmed, 2010), I looked at history through an ideal lens (Dicker, 2011) and aimed to right all the wrongs (Bubner, 2003). Within the critical paradigm, with idealism as ontology, I felt comfortable en route to the end goal of a more valuable resource when handling the mathematics textbook.

3.2.3. Epistemology

Critical epistemology is "based on real world phenomena and linked with societal ideology" (Scotland, 2012:1). Social constructionism argues that we are born into culture, into a world already known, making us subjectively part of the system. "We come to inhabit a pre-existing system and to be inhabited by it" (Scotland, 2012:3). The critical paradigm does not simply accept this reality but rather challenges it (Guba & Lincoln, 1994). Reality is alterable by human interference and the critical paradigm seeks to improve on this reality (Scotland, 2012).

Giroux (1988) described transactional or subjective epistemology as teaching how we are a part of the knowledge. We cannot separate ourselves from it, thus making us a subjective participant in all forms of knowledge. When analysing textbooks, I often found myself personally involved in the text and my own pre-knowledge as an EAL speaker influenced the way in which I adapted the textbook to suit the learners. As Bubner (2003) suggests, my subjectivity was not problematic but rather helpful in striving for my ideal solution.

According to Scotland (2012), the critical paradigm seeks to find what is intrinsically worthwhile. Thus, the critical paradigm is normative; it considers how things ought to be by judging reality. The utopian or idealistic aspirations of the critical epistemology may never be realised but a more democratic society may materialise.

When transactional epistemology and idealism are combined, a transcendent idealism is born. This was first explained by Kant in 1787 (Morton, 2002) and is an excellent example of how prior knowledge can contribute positively to the current research. In the next section, the research design will be described and its use justified.

3.3. The research design

3.3.1. Qualitative research

The obvious difference between quantitative and qualitative research lies in the data (Guba & Lincoln, 1994). When data are sampled systematically and objectively (Creswell, 2013) and interpreted numerically or statistically (Patton, 1990; Cohen et al., 2007), a quantitative research design would be most suited (Maree, 2016). My subjective role as researcher, along with the linguistic, descriptive nature of my data, were the first hints that a qualitative design would be a better fit. Qualitative data are sampled specifically (Gage, 1989) and most often also subjectively (Maree, 2016). Qualitative data are then analysed and interpreted linguistically (Blaikie, 2000; Denzin & Lincoln, 2000; Maree, 2016).

Qualitative research allows for the examination of more complex social questions (Ritchie & Lewis, 2005), thus allowing the exploration of new theories (Creswell, 2013). According to Ahmed (2010), in seeking improvements, the UAE can only benefit from more in-depth research regarding social context in educational settings. The textbooks would thus be a logical starting point (Snyder, 2014). Al Falasi (2004) notes that social issues need to be addressed before a plausible solution can be found for the stresses in the current education system. Alzahrani (2014) agrees with both Ahmed (2010) and Al Falasi (2004) that the only research design adequate for this dilemma is of a qualitative nature.

From a design perspective, the purpose of my research was not to test a theory but rather to build a hypothesis on real-world information. The intention of my research was to understand the problem, a characteristic attributed to qualitative research (Gage, 1989; Silverman, 2013). According to Baškarada (2014), the naturalistic nature of a qualitative research design allows the researcher to be non-manipulative and open to all possible matter that emerge from the data. Although I have some experience in the field and could predict some of the outcomes, there was a lack of predetermined boundaries to the findings. This led to me to accept that my inquiry would need to be adaptable, flexible and open to change.

Qualitative research is a dynamic (Hammersley, 2008), emergent (Hammersley, 2008) and flexible (Maree, 2016) process and thus in line with my design. Ritchie and Lewis (2005) state that information-rich samples are taken and Swanepoel (2010) and Baškarada (2014) add that fieldwork is a prerequisite for these samples to be explored and analysed. I started the research in the UAE, while teaching at a British school, and continued my research in this setting, thus meeting these requirements.

When I started collecting data from the mathematics textbooks, I focused on acquiring an in-depth understanding of the content and how the learners could relate to the content, if at all. Patton (2002) accords the qualitative researcher the task of being the primary research instrument, while Creswell (2013) describes the personal experience and engagement of the researcher as beneficial to the data interpretation. In the UAE, cultural sensitivity in the educational setting is of high importance, exhorting me to be empathetically neutral, another trait of qualitative data collection (Creswell, 2013; Nieuwenhuis, 2016; Silverman, 2013).

In a qualitative research design, the aim is not to test any existing theories but rather to discover new concepts in an individual case (Hesse-Biber & Leavy, 2011). This rang true when I started analysing the data collected from the mathematics textbook. I began by exploring the samples, as suggested by various authors (Patton, 1990; Hammersley, 2008; Silverman, 2013) on qualitative research, and then immersed myself in examples taken from the textbook and adapting the literacy levels to understandable, workable resources for the learners. As suggested by Cohen et al. (2007) and Swanepoel (2010), I constantly reflected on the data analysis, attempting to balance subjective knowledge and experience with interpreting the results in context.

3.3.2. Critical discourse analysis

The word *critical* has relevance throughout my research. Not only did I look through the lens of the critical paradigm but my theoretical lens was also guided by the critical theory. A CDA research design was the logical choice. Linguistic formalities from a social context originated the CDA design (Wodak, 2001) and Ahmed (2010) and Johansson (2005) confirm that the textbook forms part of the linguistic formality of society, making CDA both relevant and ideal for my discourse.

From the literature, five principles of CDA became relevant and applicable to my research.

The first principle is identified by the interdisciplinary nature of CDA (Seale, Gobo, Gubrium & Silverman, 2007). Van Dijk (1993), Seale et al. (2007) and Wodak (2001) assert that CDA does not attempt to be a single theory or methodology but is rather an eclectic marriage of several theories and methodologies. Wodak (2001) highlights this principle when explaining that CDA aims to understand a phenomenon holistically and, in order to do so, a variety of skills and theories will have to be applied. Huckin (2004) describes CDA as an approach to text analysis where nothing is described in exhaustive detail but rather specific features are focused on that could aid in the critical understanding of the social impact of the text. Since I aim to discover the possible shortcomings of mathematics textbooks for use in the UAE, CDA is a perfect fit.

Seale et al. (2007) describe the second principle of CDA as an evoking agent, where the samples and research participants are made aware of their position in context. Blommaert and Bulcaen (2000) describe a critical analysis of the discourse as a method for identifying the barriers that hinders sufficient progress. My research diary showed several examples of how the mathematics textbook was not effective in teaching the related content and where the learners' social context was ignored by the authors of these textbooks. In essence, this is what Rogers (2003) refers to as an oppressed, oblivious social group but not within the traditional political definition, which Wodak (1996) points out as not ever-present and often oblivious to the realistic needs of society. CDA attempts to point out and then narrow the gap between social discrepancies (Van Dijk, 1993; Wodak, 2001; Seale et al., 2007). By pointing out the inadequate adaptations in textbooks, CDA was invaluable in this research.

The history of the UAE is contextually essential and has direct relevance to the third principle of CDA research design. Ghamri (2012) notes that the educational background of the UAE proved to be inconsistent and ever-changing. Abosalem (2016) argues that the history of the UAE influences the context of teaching in classrooms and Snyder (2014) reasons that this is one of the great barriers in the classroom. Since most teachers are fairly new to the UAE (Alzahrani, 2014), they are often ill-equipped to deal with the social context and the textbooks then become an invaluable resource (Abosalem, 2016; Snyder, 2014). Huckin (2004) argues that CDA leans towards solving real-world problems by not ignoring the history of the social context in which the research takes place.

In the critical discourse on diversity in international school, the fourth principle of CDA can be applied, namely, ideological complexity (Seale et al., 2007; Wodak, 1996). Seale et al. (2007) reason that within great diversity lies great opportunity in terms of applying correct strategies in order to understand the holistic practice. A school of 3300 learners may have 88 different nationalities, and in a classroom of 30 learners as many as 21 different cultures have to be taken into consideration. Wodak (1996) warns that the lack of definitions would have a negative impact on the trustworthiness of a CDA and Huckin (2004) and Dicker (2011) urge the CDA analyst to set boundaries to all samples and participants prior to the research analysis. In applying the knowledge set out by Seale et al. (2007), Blommaert and Bulcaen (2000) and Wodak (2001), I focus not on learners' ethnicity but rather their English language capability, their knowledge of the United Kingdom and the cultural sensitivity that applies in the context of the UAE.

Blommaert and Bulcaen (2000) add the fifth principle of CDA when addressing the issue of language in context. Seale et al. (2007) describe CDA as a place in research where language and ideology meet, while Terre Blanche, Durrheim and Painter (2006) refer to CDA as a manifestation of ideology in language. Since mathematics has a language on its own (Johansson, 2005), it is essential that the language of instruction should be understood prior mathematics instruction can be optimally exercised (Al Falasi, 2004; Abosalem, 2016; Crawford, 2003). This implies that learners should be comfortable with the language of instruction, in this case English, before they can truly understand the language of mathematics. In the realm of CDA, language refers not only to the spoken word (Seale et al., 2007) but can also encompass visual aids and other non-verbal methods of communication (Dicker, 2011). This is consistent with multiliteracies as a conceptual framework, as described in Chapter 2.

CDA is a complex system which cannot be regarded as a step-by-step methodology (Huckin, 2004) but rather as a practical analysis of real-life data (Wodak, 2001). The qualitative, critical researcher constantly attempts to both understand the current problem (Creswell, 2013) and strive to discover possible improvements (Cohen et al., 2007). Hence, using this design, I felt confident to answer the original research questions as set out in Chapter 1.
In the next section, the choice of a case study will be motivated and the methodology pertaining to the data collection will be described and discussed.

3.4. Methodology

3.4.1. Case study

A popular method of qualitative research is the case study (Stake, 1995; Yin, 2009; Silverman, 2013) where a smaller, more specific sample is chosen by the researcher (Eisenhardt, 1989) to fit the purpose of the study in context (Stake, 1995). Nieuwenhuis (2016) states that a case is a bounded entity but that the boundary between the case and the context may be blurred.

Yin (2009), Stake (1995) and Nieuwenhuis (2016) suggest that placing boundaries on a case study helps aim the focus of the research. Case study research can be bounded by time and activity (Stake, 1995), time and place (Creswell, 2013), and by definition and context (Yin, 2009). Yin (2009) advocates case study research when "how" questions are posed, making this design suitable for my own research. The case study design often revolves around observations and holistic approaches (Nieuwenhuis, 2016).

The following table identifies three analytic features of case study research and how these features were applied in my research.

Table 3.2: Features of the case study applied

Feature of case study research	Application to my research
Each case has boundaries (Silverman, 2013).	Two textbooks in one curriculum for a specific year group were chosen. Both textbooks are used in international schools in Abu Dhabi.
The unit of analysis should be defined at the outset in order to maintain the research strategy (Punch, 1998).	The main research question will be guided by three secondary questions, including literacy, social context and environmental factors. These will form the units of analysis.
Case studies aim to address specific features of the research problem, without losing integrity of the case (Yin, 2009; Punch, 1998).	My research diary consistently kept my focus on the research questions. I was teaching in the exact context of my research site and this ensured that I was holistically involved in the research.

Nieuwenhuis (2016) uses the research of Baxter and Jack (2008), based on the works of Yin (2003) and Stake (1995), to distinguish between different types of case study. Instrumental case studies are used to understand something other than only the particular situation (Maree, 2016). Stake (2000) describes an instrumental case study as cases being studied in depth but the focus remains on something else. In my research, while the focus was mathematics textbooks, the social context of the UAE and the literacy levels of the learners in international schools in the UAE were never dismissed. According to Creswell (2013), the case plays a supportive role in facilitating a primary issue.

When looking for a more holistic view on a problem, a case study would serve well (Terre Blanche et al., 2006). Since I only explored a specific set of textbooks in a specific context, where the results could be used to address a broader issue throughout the whole UAE, the instrumental case study was an ideal and suitable choice.

3.4.2 Data collection

In qualitative research it is common for data collection and data analysis to happen simultaneously (Maree, 2016). This is, to great extent, exactly what happened during data collection for my research and my research diary is proof of this. As I collected examples from textbooks, I noted the time and effort involved in adapting the content to become a workable resource for the learners in my research diary. This then served as simultaneous analysis. Within the critical framework and in applying CDA, my data collection activities were under constant scrutiny and I looked at every page in the textbook from a critical theoretical stance. Although I soon realised that not all the data collected would be used when analysing critically, the research diary still proved to be a valuable guide in directing data collection and analysis.

Accordingly my data collection activities in the application to my own research, in line with Creswell (2013), are summarised in Table 3.3.

Table 3.3: Summary of data collection activities

Data collection activity	Summary of application in my research
Locating site	No formal research site was necessary, as a CDA was carried out on textbooks. However, I was teaching in the UAE, at a British International School, which links the site directly to the samples and the context of my research.
Gaining access to the site and samples and establishing rapport	As I was residing and teaching in the UAE, access to the site was automatic and rapport was established in September 2017. The textbooks I chose as samples, were readily available for use in schools.
Purposeful sampling	I carefully selected the two most used mathematics textbooks in British international schools in the UAE, which were aimed specifically at the IGCSE examination through the Edexcel examination board,
Collecting data	The textbooks, in conjunction with a well-kept research diary, formed the basis of all data collected.
Recording information	Field notes, observation notes and general discussion with co-workers were carefully recorded in my research diary.
Resolving field issues	The fact that there were no human participants made fieldwork uncomplicated. I could make extensive notes in my research diary for reflection and focus.
Storing data	Apart from the research diary, most data were stored digitally.

3.4.2.1. Site

Neither document analysis nor CDA requires a formal site for research (Guba & Lincoln, 1994) but McMillan and Schumacher (2001) argue that it is essential to select a research site that is suitable and feasible for the type of research. Creswell (2013) suggests that the research site should be not far removed from the presence of the researcher, especially in qualitative research, as the gap between practice and theory cannot be breached if the two entities are far removed. The research question proposed an in-depth, critical look at mathematics textbooks suitable for the British curriculum, Years 10 and 11, being used in British international schools in Abu Dhabi, UAE. At the time of the study, I was teaching mathematics in a British international school in Abu Dhabi and actively engaged with the textbook on a daily basis, making the research site suitable. Creswell (2013:151) warns that studying one's own "backyard" may introduce a power imbalance and even lead to negative repercussions from management if the outcome is not favourable. I am not focusing on the workplace or authority, however, but rather on the textbook as the sample for data collection.

3.4.2.2. Sampling

Purposive sampling is the most common sampling method employed in qualitative research (Nieuwenhuis, 2016) as it allows the researcher to choose cases that illustrate specific features that are applicable to their research (Silverman, 2013). This does not, however, imply that a sample can be chosen without critical thought being given to the boundaries of the cases (Yin, 2009; Silverman, 2013; Stake, 2000). I opted for mathematics textbooks in the setting of the UAE, in the context of a British international school.

According to Creswell (2013:154), "three considerations go into the purposive sampling approach in qualitative research and these considerations vary depending on the specific approach." In Table 3.4 which follows, the three considerations are listed, along with the relevance to my research.

Table 3.4: Considerations of purposive sampling and relevance to my research

Considerations of purposive sampling	**Relevance to my research**
Participants in the sample	Textbooks can serve the purpose of being defined as a participant (Johansson, 2005) and even though Creswell (2013:156) personally prefers "unusual cases", Yin (2009) argues that when dealing with documents, it is better to choose a case directly aimed at answering your research question, without influencing the data with outliers. I chose Yin's reasoning as it is of relevance for my own needs.
Types of sampling	Creswell (2013) suggests that qualitative researchers often opt to use more than one sampling strategy and that this is adaptable during the research. Where *critical cases* provide specific information about a problem (Creswell, 2013), *homogeneous* samples reduce the need for extensive samples (Miles & Huberman, 1994) and *typical cases* highlight what is normal or average (Patton, 2002). All three of these types of sampling have relevance to my own samples, proving Creswell's multi-strategic approach to be true.
Sample size	Maree (2016) argues that the type of research should determine the sample size and Yin (2009) and Creswell (2013) offer that one to four samples should be more than sufficient in case studies. The motivation for my sample size of two textbooks is discussed below.

Two important factors guided me when I chose the textbooks for the study. Firstly, I looked at all the possible textbooks that were available for use in the UAE. The international British curriculum is employed in many schools throughout the world and in total eight textbooks are available for use in preparation for the International General Certificate of Secondary Education (IGCSE). All of these textbooks have to be imported from the United Kingdom. In the UAE only six of these textbooks are available for importation, with some local bookstores also keeping stock. During a training session of mathematics teachers held on 4 September 2017, as noted in my research diary, most teachers stated that they used the same two textbooks to work from. These textbooks are also the ones used as resources in the school I taught at, making these two textbooks obvious and reasonable choices. After careful deliberation, I chose to focus on these two textbooks only, as any more samples would "dilute the level of detail" that I could possibly provide (Wolcott, 1994:4).

Secondly, the two textbooks chosen would not allow me to study all the topics, units and examples, so I would have to decide on specific units for sampling. The data collection techniques will be discussed under the next heading.

The first textbook I chose was Edexcel International GCSE Mathematics A, compiled by Turner, Potts, Waite and Hony (2014). The textbook has been divided into two books for easier handling. Together, the two books form one textbook. In the classroom, these textbooks are referred to as the *Fish books.*

Figure 3.2: Textbook set 1

The second textbook I chose was Edexcel International GCSE (9-1), Mathematics A, compiled by Turner and Potts. Again the textbook has been divided into two separate books for easier handling and together they form one textbook. In the classroom, these textbooks are referred to as the *Flower books.*

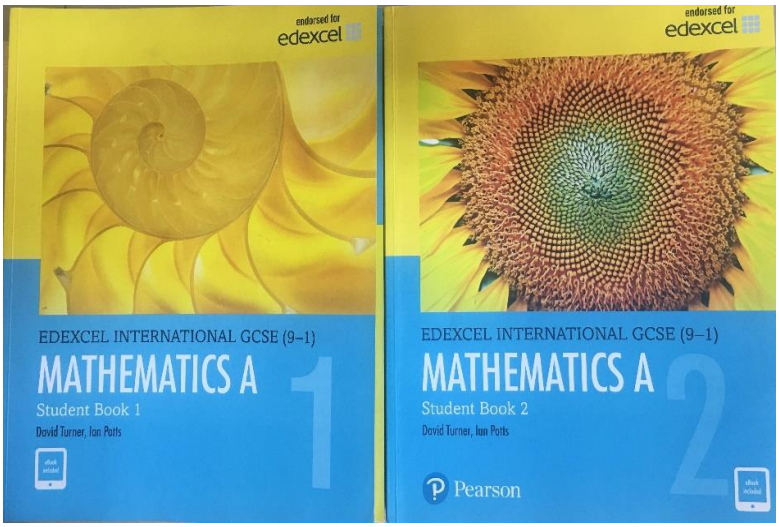


Figure 3.3: Textbook set 2

3.4.2.3. Data collection techniques

According to Creswell (2013), qualitative data can be broadly divided into four groups: observations, interviews, documents and audio-visual materials. Yin (2009) however refers to six forms of data: documents, archival records, direct observations, participant observations, interviews and physical artefacts. New methods of data collection are constantly emerging and researchers are urged to be creative when collecting data (Creswell, 2013).

Textbooks form a part of the public domain (Johansson, 2006) and are readily available for use in classrooms. According to Yin (2009), Creswell (2013) and Ahmed (2010), this is a relevant and logical argument for omitting human participation and Silverman (2013) offers the research diary as an integral part of such a strategy. Field issues that often arise when doing document research may pertain to availability of documents (Creswell, 2013) and permission to use the material (Yin, 2009). Since textbooks are in the public domain and form part of the social context (Ahmed, 2010; Johansson, 2005), none of these issues arose, limiting my field issues to time constraints and legibility of my own handwriting in the research journal. This was overcome by setting a detailed schedule to ensure all data were collected before the end of May 2018 and the highlights of my research journal were retyped and stored digitally.

I let my secondary research questions be the guide for the units chosen. The first secondary question dealt with literacy, making the first units ideally suited, as this is where most mathematical definitions are presented. I did, however, look at several more examples in other units in the textbook, especially in the unit dealing with probability, which could serve as examples of what I was aiming to understand: Is the literacy in the textbook adequately adapted for use in an EAL classroom in the UAE? My second secondary question dealt with environmental factors that are not applicable in the UAE context.

I opted to focus on the units of data handling, where learners are required to analyse data tables, graphs and visual information, as environmental descriptions are frequent and have to be understood before the concept can be applied. I noted the suitability of these descriptions to the real-life context of the students in the classroom. The third secondary research question addressed the social context of the UAE. When dealing with this question, the unit on money became relevant but I also looked at photos, drawings and pictures throughout the textbook to focus on physical differences between the textbook and the learners. The unit on percentages also proved to be valuable when collecting data for social context of the UAE.

3.4.2.4. Storage and organisation of data

The researcher's data storage approach is a reflection of the type of data collected (Creswell, 2013). In the technological era in which we live, it is almost unfathomable to think of data as being exclusively collected manually (Cox, 2016). While notes, research journals, rough jottings and transcripts may be done with pen and paper, the data are usually transferred to a digital format as soon as possible (Creswell, 2013; Cox, 2016; Maree, 2016). This makes storage central and easily accessible by multiple parties (Cox, 2016). As Creswell (2013) suggests, I developed a master list of the types of information I collected. I recorded this in my research diary initially but subsequently re-typed the data and stored them religiously on my computer.

I organised my data according to my secondary research questions. I used four main titles: Literacy; Environment; Social; General. This made the process of data collection more structured and kept me focused during the months of data collection. I bought digital copies of the textbooks to make digital storage easier and I ensured that I continuously made backups of

the data. The themes or categories I used in the organisation of my data are described in the next section.

3.4.3. Data analysis

Qualitative data analysis is nested in an "interpretative philosophy that is aimed at examining meaningful and symbolic content of qualitative data" (Nieuwenhuis, 2016:109) and is not "off-the-shelf" (Creswell, 103:182). The main purpose of qualitative data analysis is to "allow research findings to emerge from the significant themes inherent in raw data" (Nieuwenhuis, 2016:109). Dey (1995:78) claims that qualitative researchers often revert back to "insight, intuition and impression" and this implies that they are always learning. The qualitative data analysis process tends to be non-linear, meaning that all elements of data, including collection, sorting, and interpretation and analysing, are intertwined and not a step-by-step process (Nieuwenhuis, 2016).

Seidel (1998) developed a model, consisting of three key elements, to assist in the data analysis process. The key elements are cyclical – noticing things; collecting things; thinking about things (reflecting). This suggests that during my research, gaps could be identified where more data were needed and I could then go and search for these data. By collecting the data and sorting them thematically or by category, the data analysis process is given structure, necessary even within a qualitative design (Maree, 2106; Creswell, 2013).

Nieuwenhuis (2016) argues that the data analysis should be appropriate for the research design and since I was working within a critical paradigm, with critical theory as framework, the CDA design was a logical progression of my research process.

In the next section, the traditional approach to document analysis will be described, followed a substantiation of my application of a CDA approach, as well as a discussion on the thematic analysis of the data, the criteria set for analysis and, lastly, my role as researcher.

3.4.3.1. Traditional approach to document analysis

In the qualitative research field, three general approaches are accepted – interpretive, systematic and traditional (Creswell, 2013). Yin (2009) argues that in case study design, the traditional approach is most effective, as the descriptions of data will have great importance. In a traditional approach, patterned regularities can be highlighted, reducing codes into themes

(Wolcott, 1994) and the data can be described in detail (Maree, 2016). The thematic analysis of my research is described later in this section. Yin (2009) describes traditional text analysis as a process where data, taken from documents or texts, is placed into different categories, while Wolcott (1994) highlights that the traditional approach is ideal for linguistic interpretation.

3.4.3.2. Critical discourse analysis

Nieuwenhuis (2016:113) states that "there is no general consensus as to what discourses are or how to analyse them" but CDA gave direction and shape to my process. Nieuwenhuis (2016:113) sets out six questions that the CDA researcher should focus on. This is particularly relevant in a case study where document analysis is applied. Accordingly, in Chapter 4 I will strive to answer these six questions, providing applicable supporting material from the data collected.

1. How is this text shaped by what it does in the world, what is it about, how is it related to the world of the audience?
2. How is this text shaped by what human language is like in general, and by what the text originator's particular language is like?
3. How is this text is shaped by who the audience is, who the speaker is, what the relationship between the speaker and the audience is, who else is listening and how are they related to each other?
4. How is this text shaped by what people expect to hear in this context, how they expect it to be said, what they expect it to be meant to mean?
5. How is this text shaped by its medium? What sorts of differences can make it whether people are interacting face to face or at a spatial, temporal or social distance?
6. How is the text shaped by purpose, intention, or by what speakers and audiences are trying to accomplish?

A CDA design aims to not only understand the underlying problem, but also to seek out possible solutions (Rogers, 2003; Yin, 2009). Blommaert and Bulcaen (2000) argue that CDA is ideal for analysing data where unfair treatment of one of the parties can be seen, without trying to prove the unfairness. Discrepancies are accepted in CDA (Wodak, 1996) and when

used in conjunction with the critical theory, a journey of discovery to a possible better outcome is begun (Van Dijk, 1993; Wodak, 2001; Blommaert & Bulcaen, 2000).

To fully understand the context of the visual aids in the textbooks, in conjunction with the worded text, I applied the two phases of CDA strategy described by Huckin (2004). Phase 1 relies on the non-critical evaluation of the text. This meant that I had to look at the textbooks through the eyes of the learners, without thinking of possible adaptations to make the learning process more efficient. In the second phase, the researcher has to purposefully distance herself from the context, in order to critically evaluate the text and the discoveries made during the first phase. According to Huckin (2004), it is imperative that these two phases are never separated from one another, as the critical reader should also experience the text from the perspective of a non-critical reader. It is during the second phase that a more structured and chronological method is applied.

Table 3.5 in chapter 3 indicates the chronological method applied in my research.

Table 3.5: Order of critical reading

Order of critical reading:	**Application:**
Language	Looking through the textbook, taking note of how many words there are per page, how white space is used and looking for mathematical definitions relating to the specific content
Visual aid	Critically examining visual aids in the textbook, making notes on their effectiveness and usefulness and even the learners' ability to understand the relevance, keeping in mind the social context and religious sensitivities of the UAE.
Examples	Specifically looking for examples used in content descriptions that may form barriers between learners' conceptual understanding and personal experience.

Source: Huckin (2004)

By reading the text in this order, I was gradually able to investigate the content more critically and with a better frame of reference, as suggested by Creswell (2013) and Huckin (2004). In the next section, my choice of thematic analysis will be described and substantiated.

3.4.3.3. Thematic analysis

The amount of data collected in qualitative research tends to be vast and expansive (Nieuwenhuis, 2016). Data management is thus a logical first step to take after data collection has begun (Creswell, 2013). It is therefore essential to organise the data in order to keep from being "overwhelmed by the sheer amount of data" (Nieuwenhuis, 2016:115). When working with documents, an effective way of categorising the data is to code it. These codes can later be critically analysed and arranged into themes (Seidel, 1998; Creswell, 2013; Wolcott, 1994).

When looking at data, *codes* are initially used to help divide the data into categories (Dey, 1995; Nieuwenhuis, 2016). These codes in turn guide the organisation of data into to clearer and more detailed themes or categories (Babbie & Mouton, 2001; Creswell, 2013).
Stemler (2001) distinguishes between a priori and emergent coding, where a priori themes are decided on prior to research and emergent themes emerge as the research progresses. Since I was teaching in the school that used the British curriculum prior to my research, I had already informally identified themes or categories that were relevant for my formal research.

When I started the research, this prior knowledge not only guided me also led to the formulation of my secondary research questions. Nieuwenhuis (2016) and Braun and Clarke (2006) suggest that if data cannot be assigned to a specific code immediately, they can later be examined more thoroughly and a decision can then be made about their relevance, although as Wolcott (1994) states some of the data will be discarded. This made me feel comfortable about collecting as much data as possible. In this way I could omit irrelevant data or even create a new theme if necessary, giving my research the structure it required and the flexibility to extend it if necessary. Creswell (2013) and Braun and Clarke (2006) indicate a step-by-step methodology of analysing data in a case study. Taking guidance from both of their analytical strategies, I formulated my own steps for analysing the data.

Table 3.6: Steps in thematic analysis applied in my research

Steps in thematic analysis	Description
1. Getting to know the data	Read through the textbook as a non-critical reader, as Huckin (2004) suggests. Make notes as a starting point.
2. Creating initial codes	Group all similar examples and notes together informally, work systematically through both textbooks and ensure the codes are linked accordingly.
3. Classifying data into themes	Use of aggregation to establish themes for the coded data.
4. Revising themes	Go through the textbooks again, this time as a critical reader (Phase 2 of Huckin (2004)). This ensures that the codes are relevant and effective.
5. Interpreting data	Generalise findings and interpret data directly. Analyse data to make sure that the findings are linked to the primary research question.
6. Representing the data	Use effective and relevant examples to present the findings

Step 1

Huckin (2004) suggests that the first time the data is read it should be from a non-critical standpoint. This not only serves the purpose of getting to know the data, but also helps orientate the researcher to identify possible codes (Braun & Clarke, 2006; Babbie & Mouton, 2001). I looked at the textbooks from a learners' perspective and made notes on things they might question regarding content, visual aids and literacy use. I did not try to deliberately find answers to my research questions, but rather intended to just get a better understanding of the textbook as a holistic classroom resource.

Step 2

When assigning initial codes to data, it is important to not be stingy with the data (Braun & Clarke, 2006). According to Creswell (2013) there is no limit on the number of codes you can start off with, as long as they are all relevant to the context of the data (Braun & Clarke, 2006). The same piece of data can be assigned multiple codes (Braun & Clarke, 2006) and vague descriptions should be avoided (Babbie & Mouton, 2001). The CDA refers to this step in analysis as the description of the data (Blommaert & Bulcaen, 2000), while Braun and Clarke (2006) describe it as the semantics phase. This is purely a description of what can be seen from a non-critical reader's point of view (Huckin, 2004) and does not attempt to come up with any possible solutions as the critical theory would suggest (Maree, 2016).

Step 3

In step 3, the primary and secondary research questions are aligned to the data coded in step 2 to decide on more delineated and structured themes for analysis. A hierarchy of themes are put in place, with no data being disregarded (Braun & Clarke, 2006). It is important to note that these themes are not final and that they can be adjusted and changed throughout the analytical process (Dey, 1995; Nieuwenhuis, 2016; Stemler, 2001). This step is imperative in guiding the researcher to answer the original research question (Maree, 2016).

Step 4

Armed with more structured themes, the researcher will find the critical reading of the text, as suggested by Huckin (2004), easier and more focused (Creswell, 2013; Wolcott, 1994). The essence of this step is to ensure that the themes are sufficiently supported by examples extracted from the text (Braun & Clarke, 2006) and that the themes chosen are relevant and sufficient for the data (Creswell, 2013; Babbie & Mouton, 2001).

Step 5

As previously described, the second phase proposed by Huckin (2004) will entail a more detailed analysis of the language, visual aids and examples used in the mathematic textbooks. During step 5 I will also marry these broad categories with the more specific themes, as indicated by my secondary research questions, including social context, environmental differences and language usage in the classroom. References to my research diary will make the process of analysing the data in detail more descriptive. During step 5, all uncertainties

regarding themes should be eliminated (Braun & Clarke, 2006) and the findings should be directly interpreted.

Step 6

Creswell (2013:191) suggests that in the final stages of analysing data, an "in-depth picture of the case" is required. The final stage involves a presentation of all the thematic findings in such a way that these findings can be generalised (Maree, 2016; Creswell, 2013). Eventually, a detailed narrative of the case study should be presented (Braun & Clarke, 2006) so that the data can make sense to the reader (Babbie & Mouton, 2001).

3.4.3.4. Criteria for analysis

In qualitative research the criteria for analysis are expansive and highly subjective in terms of the paradigms, theories and methodologies employed (Silverman, 2013; Creswell, 2013; Maree, 2016). Devetak and Vogrine (2013) identify nine general quality criteria for textbooks, four textual material quality criteria and seven pictorial material quality criteria. These sets of criteria, or very similar sets, can also be found in the research of Johansson (2005), Wen-Cheng (2010), Swanepoel (2014) and Henning (1996).

The following list of criteria guided my thematic analysis:

1. The structure is clear and transparent: learners can easily find their way through in the textbook.
2. Technical guidance is considered: all technical details are correct, including correctness of content, copyright is not infringed and proofreading has been done.
3. The content is consistent with the learning objectives.
4. The content is didactically adequate: the needs and abilities of learners are taken into consideration when adapting the content of the textbook.
5. The text is linguistically appropriate: unknown or difficult words are defined and explained.
6. Visual aids are relevant and appropriate: pictures are suitable for learners and add value to the content, while not being distracting.

3.4.3.5. Role of the researcher

As researcher I have taken on the following roles regarding the data:

1. Consistently keeping a research diary.
2. Assigning codes to the semantic units in the textbooks.
3. Performing thematic analysis of the data collected.
4. Analysing and interpreting the collected data and presenting the findings.

My personal experience will contribute to the data collected, as the way in which the learners accept the content of the textbooks has direct relevance for the findings. Therefore, my research diary proved invaluable during the data analysis phase. It contained all the themes and codes noted during the data collection and data analysis phases, with accompanying notes on how the textbooks were received and used by learners. Detailed descriptions of conversations with colleagues were noted, along with all informal conversations that took place at events like Mathematical Professional Development, Getting Ready to Teach A-level, presented by Pearson, and other events hosted in the UAE. My personal observations were all written in my research diary, ensuring that, upon reflection, a holistic picture could be formed of the research site and data.

To ensure that all notes and observations in my research journal were useful, I acknowledge the guidelines as set out by Silverman (2013):

* Write down all observations as soon as possible.
* Refrain from conversation about observations before writing them down.
* Refrain from editing observations.

The role of the qualitative researcher is subjective (Maree, 2016) and therefore it is essential that quality assurance measures be taken (Silverman, 2013). These will be discussed in the next section.

3.5. Quality control

3.5.1. Credibility

When reading through my research diary, I found that the credibility of my research was inherently addressed because I worked from the textbooks (samples chosen) in the setting of a British international school (site). This proved to be congruent with the research findings in reality (Nieuwenhuis, 2016). Denzin and Lincoln (2001) argue that there is no single way in which to interpret reality and that credibility can only be established if the researcher has played an active part in the research. Credibility is often referred to as the starting point of quality assurance in research (Lincoln & Guba, 1994) and can be confirmed in the rich and detailed descriptions of the case study (Nieuwenhuis, 2016; Yin, 2009). In this case study, the linguistic description of the mathematics textbooks forms the basis of credibility, with the CDA as enrichment. According to Blommaert and Bulcaen (2000), CDA contributes to credibility by being a critically descriptive method for addressing research, liaising between linguistic and scientific analysis of the data and finally keeping focus on the immediate research setting.

3.5.2. Transferability

Quality assurance markers in case studies vary according to the requirements of the specific case (Yin, 2009) and, according to Nieuwenhuis (2016), other researchers should be able to find some meaning and value when reading through the case. In the UAE there are 28 British secondary schools where mathematics is a compulsory subject. This makes transferability possible, logical and relevant.

3.5.3. Dependability

Qualitative research prefers dependability over reliability (Nieuwenhuis, 2016) and in most cases depends on credibility (Lincoln and Guba, 1985). Dependability does not have to be addressed explicitly if the right methods have been employed to prove credibility (Lincoln &Guba, 1994) and the possibility of change is not ignored (Maree, 2016). The parameters of my research were put into place during the literature review and adaptations were made during data collection, proving the dependability of the research in reality, a valuable technique that can be used in case studies (Yin, 2009).

The following table shows the process of dependability applied with my data:

Table 3.7: Dependability of data with set parameters

Research question to answer	Textbook used	Units analysed
Are the literacy levels in the textbook suitable for the learners?	Fish books Flower books	Unit 4, Number 4 Unit 5, Handling data 4 Book 1, Unit 5 Book 2, Unit 4
Have environmental factors in the UAE been addressed in the textbook to make the content relevant for the learners?	Fish books Flower books	Unit 2, Handling data 1 Unit 6, Sets 2 Book 1, Unit 2 Book 2, Unit 1
Has the textbook been adequately adapted to address the social context of the UAE?	Fish books Flower books	Unit 9, Number 9 Pictures used in both textbooks Book 2, Unit 5 Pictures used in both textbooks

3.5.4. Confirmability

Lincoln and Guba (1985) describe confirmability as the neutral stance maintained by the researcher throughout the research. Qualitative researchers are subjective and biased (Maree, 2016), but this does not imply that the credibility of the research has been compromised (Creswell, 2013). Keeping a research diary, staying focused on the content and continuously monitoring progress with my supervisor ensured that the research steps taken to ensure confirmability were followed.

3.6. Ethical considerations

Ethical researchers are aware of their bias, focused on answering the primary research question and not influenced by the subjective opinions of others (Maree, 2016; Creswell, 2013). The rules and regulations of all parties involved, including the government, university and personal entities should not be ignored (Yin, 2009; Maree, 2016). I understand that since I will be undertaking research in the UAE, through the University of Pretoria in South Africa, the ethical considerations should include both countries' research regulations.

I was granted ethical clearance by the University of Pretoria in September 2017 as part of their international research programme, reference number UP 16/09/01 Wasserman 17-002. I indicated that all research would be done from textbooks and no participants would be involved. As long as I adhered to my original data collection strategies and did not involve any other form of data collection technique, no ethical boundaries in the UAE would be broken.

3.7. Conclusion

In this chapter, the research design and methodologies used were described in detail and the choices pertaining to data collection techniques and analytical strategies were substantiated. In the next chapter the data will be described, examples will be given and the findings will interpreted.

CHAPTER 4: DATA ANALYSIS

4.1. Introduction

In the previous chapters, a detailed literature review was conducted and the theoretical components of the research were described, including the methodologies and paradigms applied. This chapter focuses on the data. I employed Huckin's (2004) two phases for data analysis, namely, non-critical and critical readings of the textbook. Following the data description and the critical interpretation of the data, I concluded each section with a discussion of my findings. In addition, when compiling this chapter, I used Seidel's (1998) cyclical data analysis process.

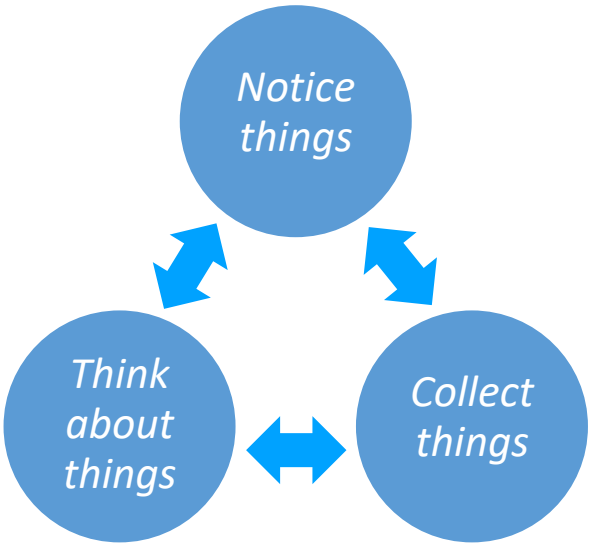


Figure 4.1: Cyclical process of data analysis
Source: Seidel (1998)

Throughout this chapter I will often refer back to *noticing*, *collecting* and *thinking about* the data, to ensure consistent use of this cyclical process.

To ensure that the data are described, analysed, interpreted and evaluated in a structured manner, initial codes were used during data collection. These codes led to more specific themes and these themes are used in this chapter to give logical structure to the data. The summative table that follows indicates how the codes led to themes and sub-themes. These themes and sub-themes relate to the original secondary research questions and will be discussed in this chapter.

Table 4.1. Summary of codes, themes and sub-themes used to collect and evaluate data

Initial codes	Themes	Sub-themes
A. Too many words on a page B. Words not understood by learners C. Sentences too long D. Examples not understood by learners E. Descriptions vague, irrelevant or inadequate F. Limiting visual aids due to language barriers	1. Literacy levels	1.1. Definitions 1.2. Layout of pages 1.3. Visual aids
G. Examples not in learners' frame of reference H. Questions not understood because of learners' inexperience I. Non-relevance of content J. Irrelevant information in a mathematical context	2. Environmental factors	2.1. The weather 2.2. Geographical depiction 2.3. Money matters
K. Unsuitable example/question owing to religious restrictions L. Picture or visual aid unsuitable for UAE context M. Unsuitable information in relevant mathematical content N. Unsuitable information in irrelevant content	3. Social context	3.1. Religious restrictions 3.2. Cultural sensitivity

The codes led to themes that were aligned with the secondary research questions and from these questions certain sub-themes naturally emerged. These sub-themes guided the data analysis and kept the non-critical observations, critical analysis and personal findings structured throughout the descriptive phase of Chapter 4.

The primary research question sought to answer how British mathematics textbooks should be adapted to consider the context of international secondary schools in Abu Dhabi. However, in this chapter, it is the secondary research questions that are important. These subsidiary questions served not only as guideline in my research to ensure that I kept focused on answering my primary research question, but they were also directly linked to the themes that stemmed from the initial coding.

The secondary research questions, with the themes in bold, are as follows:

1. How can the **literacy levels** in British mathematics textbooks be adapted to consider the literacy standards in the international secondary school in Abu Dhabi?
2. How can the content of the British mathematics textbook be adapted to consider the **environmental differences** of Abu Dhabi?
3. How can British mathematics textbooks be adapted to consider the **social context** of the UAE?

The two textbooks that served as samples and were chosen for this research are written specifically for the British curriculum, Years 10 and 11, with the aim of the learners completing the IGCSE examinations at the end of Year 11. To make referencing to the different textbooks easier, I will refer to the two different textbooks in the following manner:

Edexcel IGCSE, Book 1 & 2 by Turner, Potts, Waite, and Hony will be referred to as the *Fish* books, as can be seen in Figure 3.2 in the previous chapter.

Edexcel, IGCSE, Book 1 & 2 by Turner & Potts, will be referred to as the *Flower* books, as can be seen in Figure 3.3 in the previous chapter.

Since the titles of both sets of books are similar, the need for easier identification was realised with the outset of the research and the colloquial reference to these books is often mentioned in my research diary.

The next section is dedicated to a general description and the levelling system of the IGCSE curriculum and how the textbooks aim to address this. The relevance of this information pertains to the macro-context, that is, understanding the aim of the textbook. If the aim of the textbook is defined, the effectiveness of the content can be related to the classroom context in the UAE and ultimately the success of the textbook as a useful resource can be determined. When answering the primary research question, this contextualisation cannot be ignored.

4.2. IGCSE curriculum and the levelling system

The following introduction serves as background information to assist in understanding the importance of the textbooks as a resource for preparing for the IGCSE examinations. Both textbooks chosen as the sample are specifically adapted for use in the international classroom where the British curriculum is followed. Teachers and learners use these textbooks to prepare for the examinations, which are set in the UK and exported to foreign countries like the UAE during examination periods.

The mathematics examination consists of two papers, written at the end of Year 11. The completed examinations are then returned to the UK for marking. This is essential knowledge, as this influences teaching of the content. For example, some students have never seen a British pound before, although they will probably encounter a question containing pounds and pennies. Contextualisation of the content for examination purposes is therefore imperative and cannot be ignored. Grades ranging from E to A* are linked to levels 1-9 throughout the IGCSE curriculum. Their relation is summarised in the table that follows.

Table 4.2: Curriculum levels related to grades achieved in the examination

Level	Grade
9	A*
8	A
7	B
6	C
5	D
3–4	E
1–2	Ungraded

The levelling system is not unique to the education realm, but plays a vital role in IGCSE teaching strategies. In Year 10, students start the IGCSE content with easier topics and questions, ranging from level 1 to 5, where level 1 questions are the easiest and level 5 the hardest. Students struggling with level 4 questions, for example, will not move on to level 5 questions. At level 5, most students should obtain a D-grade for the exam.

As the content becomes progressively more difficult, the levelled questions then lead up to level 9, which will result in an A* award. The exam is levelled in a similar fashion, where questions 1 to 10 range from levels 1 to 5 and question 11 onwards will become progressively more complex. The grade boundaries are determined by a bell curve at the end of the examination period and differ from year to year. The curriculum and levelling systems were the first focus of data collection and analysis from the textbook and will be described in the next section.

4.2.1. Non-critical observations

It is evident from the cover pages of both sets of books that the books are intended for the Edexcel IGCSE mathematics curriculum. There is a contents page at the front of every book and the course structure is laid out clearly. This should make navigation through the textbooks possible.

In the Fish books, there is a preface which describes how the book is structured and in what way exercises and questions should be dealt with. This single page is not marked as important and because of the vast number of words on this page, it is easily skipped by the reader. Words like “sequential”, “consolidate” and “numerous” are used in the preface, indicating that a certain acceptable level of English is required for understanding the content of the page. This might also be an indication of the literacy levels to follow throughout the book. The Flower books address the use of the textbook over two pages. Example pages from the textbook are used as visual aids to guide the reader on how to use the textbook. This section is clear and concise and the title “About this book” appears in large font and is bright blue in colour. The language used is simple, and longer, difficult words are described more simply.

I noticed that the Fish books do not refer to levels or grade at all, while there is an indication of the required level next to each exercise in the Flower books. In the Fish books, when starting a new topic in each unit, there is a clear title indicating the broad topic that will be discussed, but no specific learning outcomes or lesson objectives are mentioned. In the Flower books, the learning objectives are given in a text box, followed by some basic principles that will be applied in each unit. A starter activity is included on the first page of each new unit in the Fish books but no indication is given as to how this activity is relevant to the topic to be dealt with in that unit. In the Flower books, each unit starts with a picture and paragraph of text. Unit 4 in Flower Book 1, for example, starts with a picture of a four-leaf clover and a paragraph on the number four.

Both sets of books use colour and different font sizes to indicate different topics, exercises and examples. While visual aids like pictures and graphs are sparse in the Fish books, the Flower books boast frequent colourful photographs and visual aids. Units are colour-coded and every page is clearly marked with page number and topic titles Some exercises are marked with an asterisk (*) without any explanation on the same page as to what this means. From a non-critical view, it would seem that the content is adequate for the IGCSE examinations.

4.2.2. Critical analysis

Although navigation through the textbooks seems possible when looking at the course structure, the topics and units are not ordered coherently or logically. Each unit jumps between topics and there is no progressive order indicated in the course structure in either of the books. Both books aim to make the use of the textbook clear but are not particularly successful in this respect. The words used to describe the actions and expectations of learners require high-level of English literacy skills. The information is only given once, so there is the expectation that learners will refer back to this when required; however, this is never mentioned in any of the units.

The absence of the levels in the Fish books makes individual progress and attainment challenging in a classroom environment. The British curriculum requires learners to be constantly aware of their level and the progress that needs to be made, and so the responsibility for addressing the levels during lessons falls onto the teacher. The same applies with the lack of learning objectives in the Fish books. Having a broad unit or topic printed at the top of the page does not help learners when they are trying to work through a set of learning outcomes set by the curriculum. The Flower books, on the other hand, do address these issues as levels and learning objectives are clearly visible. There is a lack of lower-level exercises in both sets of textbooks, meaning that the lower ability learners will not find the textbooks as useful as the higher ability learners.

In every unit of the Fish books the starter activities are irrelevant and often confusing, nor is there a direct link between the starter activity and the content to be covered in the unit. In the Flower books, the paragraphs which start the units are also irrelevant and distracting. The following example was taken from Flower book 2 and shows a typical start to a new unit.

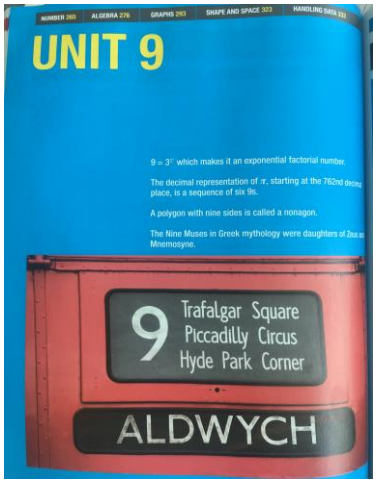


Figure 4.2: Start of unit 9 in Flower book 2 (p. 265)

The information relating to the number 9 might be interesting to a learner fluent in English but it is distracting and often confusing for learners in EAL classrooms, as noted in my research diary. The vast amount of content to be covered in the IGCSE curriculum does not allow for lessons to be spent on discussing the relevance of a picture or a paragraph, making the introduction to each unit ineffective.

The use of colour in both sets of books is commendable and makes it easy to distinguish between examples and exercises. However, the use of the asterisk after some exercises is still unclear but my guess would be that the asterisk refers to more challenging questions. Discussions on the asterisk throughout both textbooks happened frequently and it was only in the last few weeks that learners were no longer distracted by them. Conflict arises in the use of visual aids in both sets of textbooks,. The Fish book has an obvious lack of pictures but the photographs in the Flower books are often irrelevant and distracting. A picture of a piece of cake on a page dealing with worded percentage problems only became relevant after learners read the second last question on a bakery selling cakes. This begs the question as to why the photo was used to begin with as it does not assist in an understanding of the content, merely causing confusion in the classroom.

4.2.3. Findings

Seidel's (1998) cyclical process of data analysis guided the structure of my findings. The following table was taken from my research diary and will serve as guide for the discussion to follow.

Table 4.3: Summary of general data

	Notice things	**Collect things**	**Think about things**
Course structure	Both sets of books have a structured layout in the front	The layout is not particularly useful as many learners struggle to find their way around the textbooks.	The logical order of the course structure is lacking, especially for EAL learners.
How to use the textbooks	Both books have a preface or section to describe how the book is supposed to be used.	No clear instructions on how to use the books, with no in-text reference to the preface of the book.	EAL learners need constant guidance on how to work from an example and through an exercise.
Indication of levels	The Fish books have no levels indicated, but the Flower books do refer to the levels.	The levels in the Flower books are aimed at high grades.	The textbooks would be more useful for high attainers. The lack of levels creates feelings of uncertainty and insecurity.
Beginning of the units	Starter activities are present but not always relevant.	Connecting relevant starters with learning objectives and prior knowledge was not possible from the textbook alone.	Without guidance from a teacher, the starter activities in both sets of textbook were distracting and irrelevant to the topic.
Visual aids	The Flower books have more visual aids than the Fish books.	The relevance and suitability of the visual aids are questionable.	Often the visual aids were distracting and unhelpful, especially when they had to be partially covered.

Source: Adapted from Seidel (1998)

Since the units in the course structure of the textbooks are not ordered logically, learners often struggled to find the specific content they were looking for. For example: if a learner does not know that *direct proportion* will be dealt with in the *number* unit under the title *ratio,* he/she will spend a lot of time searching for examples and exercises on *direct proportion*.

The use of the textbook without the guidance of a teacher is challenging for the learners. Apart from the fact that they do not know *where* to go, they are also unsure of *what* they need to do. When I set homework from the textbook, I had to make sure that the unit, topic, page number and exercise numbers were clearly indicated and the expectations explained in class.

The lack of levels in the Fish books made knowledge of progress difficult for the learners. I spent quite a bit of time in class informing learners about the levels of questions and even more time was spent on figuring out what levels applied to specific questions. Fortunately, I could refer to the Flower books for guidance on of question levels. The content of the textbooks is sufficient for high ability learners but the lower and even middle ability learners could not use the textbooks on their own. The lack of easier questions in every unit seemed to have a negative effect on their confidence and they often gave up without even trying to do the questions.

I found the starter activities for every unit in both sets of textbooks to be distracting for the learners. Most learners struggle with English and when they are confronted with paragraphs of written words in a mathematics textbook, they are discouraged and confused. Unfortunately, I could not always skip these pages as often the topic structure, learning objectives (in the Flower books) and even the explanation of the first set of questions are also discussed on the same page. Referring back to figure 4.2 the context of the picture had a great influence on the understanding of the image. After showing the learners a picture of the red buses typically used in London for public transport and explaining that Trafalgar Square, Piccadilly Circus and Hyde Park Corner are all prominent landmarks in London, where bus number 9 en route to Aldwych will stop, the image made sense to them. Without teacher intervention, however, the image was nonsensical to most learners in class.

The use of colour in both textbooks is appropriate and useful but the visual aids lack effectiveness. Often class discussions arose on the relevance of the pictures used, instead of focusing on the mathematical content. In the section on social contextualisation, the effectiveness and relevance of pictures and suitability are elaborated.

In general, the textbooks are adequately suited for the IGCSE curriculum content but little adaptations were made for consideration to the EAL learner. In the next section a detailed description of the data in terms of literacy will assist in answering the first secondary research question.

4.3. Literacy levels in the textbooks

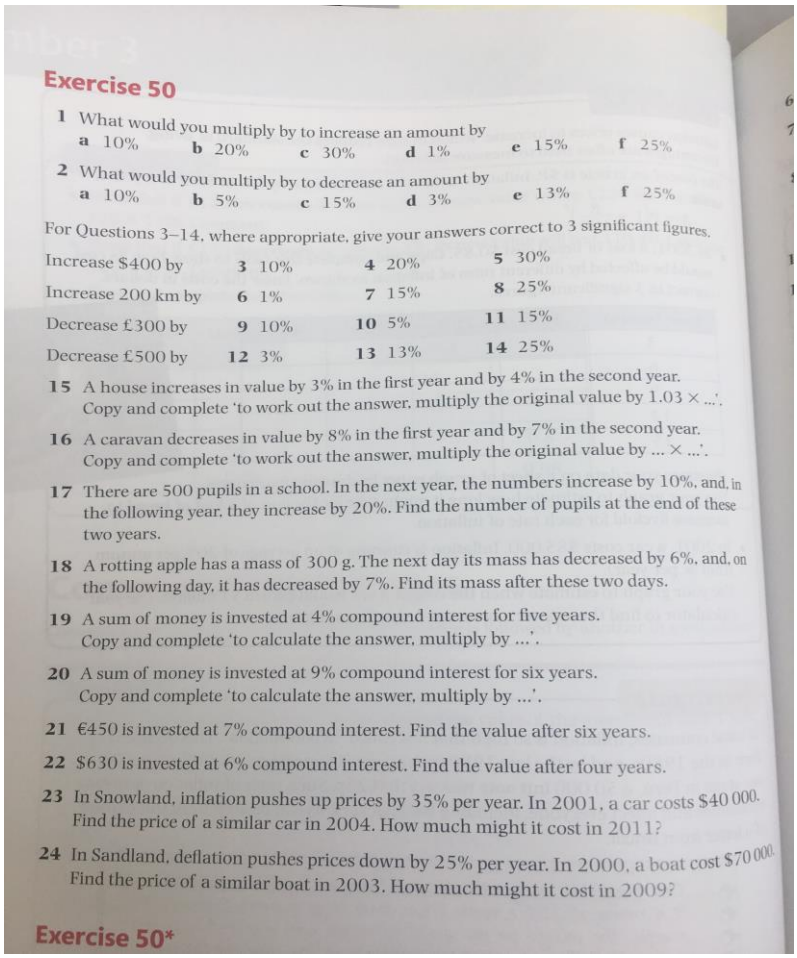
As mentioned in Chapter 1, only about 5,5% of learners in the UAE speak English as a first language, with the result that classrooms in that country are filled with predominantly EAL learners. This is important to remember throughout the three phases of research that are described in this section.

4.3.1. Non-critical observations

At first glance, the textbooks are extremely wordy. Most pages are filled with descriptions, examples, sentences and word problems. The Fish books have margins of 5 centimetres on one side of every page, which are seldom used. However, on some pages this white space is used to remind learners of key points relating to the content being covered. The Flower books have very little white space throughout the book, making the pages appear busy and full of information. Both sets of books use single spacing between sentences. The Fish books use a variety of fonts and font sizes, which are all easy to read. Text boxes distinguish between activities, examples, exercises and investigations and different colours are used to indicate topics. The Flower books are printed in smaller font sizes than the Fish books, and small arrows are used to distinguish between activities and examples. Question levels are shown in small circles next to the exercises.

Both books favour long, descriptive examples and explanations. Sentences are long and word problems are frequent. The word problems are structured in paragraphs and some pages are filled only word problems with, with little white space and limited spacing. Every unit in the Flower books starts with a paragraph of information and all learning objectives and prior knowledge required are described in long sentences

The following example was taken from Fish book1, page 112 and is an exercise on percentages:



Exercise 50

1 What would you multiply by to increase an amount by
a 10% **b** 20% **c** 30% **d** 1% **e** 15% **f** 25%

2 What would you multiply by to decrease an amount by
a 10% **b** 5% **c** 15% **d** 3% **e** 13% **f** 25%

For Questions 3–14, where appropriate, give your answers correct to 3 significant figures.

Increase $400 by	**3** 10%	**4** 20%	**5** 30%
Increase 200 km by	**6** 1%	**7** 15%	**8** 25%
Decrease £300 by	**9** 10%	**10** 5%	**11** 15%
Decrease £500 by	**12** 3%	**13** 13%	**14** 25%

15 A house increases in value by 3% in the first year and by 4% in the second year. Copy and complete 'to work out the answer, multiply the original value by $1.03 \times \ldots$'.

16 A caravan decreases in value by 8% in the first year and by 7% in the second year. Copy and complete 'to work out the answer, multiply the original value by $\ldots \times \ldots$'.

17 There are 500 pupils in a school. In the next year, the numbers increase by 10%, and, in the following year, they increase by 20%. Find the number of pupils at the end of these two years.

18 A rotting apple has a mass of 300 g. The next day its mass has decreased by 6%, and, on the following day, it has decreased by 7%. Find its mass after these two days.

19 A sum of money is invested at 4% compound interest for five years. Copy and complete 'to calculate the answer, multiply by ...'.

20 A sum of money is invested at 9% compound interest for six years. Copy and complete 'to calculate the answer, multiply by ...'.

21 €450 is invested at 7% compound interest. Find the value after six years.

22 $630 is invested at 6% compound interest. Find the value after four years.

23 In Snowland, inflation pushes up prices by 35% per year. In 2001, a car costs $40 000. Find the price of a similar car in 2004. How much might it cost in 2011?

24 In Sandland, deflation pushes prices down by 25% per year. In 2000, a boat cost $70 000. Find the price of a similar boat in 2003. How much might it cost in 2009?

Exercise 50*

Figure 4.3: An example of word exercises from Fish book 1 (p. 112)

This example is typical of most exercises in both textbooks. There are more than 20 questions per page and the questions consist of long sentences.

The Fish books have an obvious lack of definitions and descriptions, while the Flower books contain a glossary of words at the back of the book. On some pages in the Flower books, short definitions of certain topics are given. In the key descriptions in both textbooks, words like "mnemonic" (Fish book 1, p. 2 and Flower book 1, p. 313) are used. This word is used to describe mathematical acronyms like BIDMAS, used in order of operations, and FOIL, used when expanding brackets.

Complex words and phrases are used without simpler synonyms or explanations being given, for example:

Fish book 1, p. 254: “pyramidal patterns”
Fish book 2, p. 207: “suitable tangents”; “radioactive isotope of mass”
Flower book 1, p. 290: “interquartile range”; “cumulative frequency”
Flower book 2, p. 282: “disproving statements by considering … to find counter-examples …”

The lack of definitions relates not to mathematical content but also to the examples being used and the questions being asked. British jargon is used frequently throughout both textbooks, for example: “A spider is descending over Little Miss Muffet, aiming for her bowl of whey” (Fish book 1, p. 27) and “Kim is eating tea” (Flower book 2, p. 31). In Flower book 1 (p. 45) an example involving Sherlock Holmes is used and a confusing example can be seen in Fish book 2 (p. 47): “40 teenagers have all seen the film ‘Parry Hotter’”.

4.3.2. Critical analysis

The pages in both textbooks are very busy. The lack of white space make the pages appear cramped and the small line spacing does not alleviate the overcrowding on the pages. The first impression of the books is that they are not suitable for learners that who do not like reading or are not equipped with the literacy skills to decipher the long sentences in mathematical problems. EAL learners find word problems intimidating and when they are confronted with cramped pages and lengthy descriptive paragraphs, they feel discouraged. The numbers between the words get lost and so does the mathematical content.

The lack of descriptions and definitions are problematic throughout both sets of textbooks. The glossary provided at the back of the Flower books is not helpful, as it is difficult to find and not simple enough for EAL understanding. Words like “mnemonic” (Fish book 1, p. 2) might be a relevant description of acronyms like BIDMAS but is unnecessarily confusing for EAL learners. The textbooks are full of additional information, like long paragraphs on the polygons, which might be interesting to a native English speaker not intimidated by lots of words but for an EAL learner merely causes a barrier to learning. The lack of mathematical definitions in the Fish books causes irritation for both learner and teacher. If a learner does not know what a *prime factor* is, the exercises on highest common factors and lowest common multiples cannot

be completed if a teacher is not present to give the definition, thus learning at home from the textbook would not be possible.

When dealing with examples and exercises, the textbooks use jargon pertaining to the UK which is not easily understood by someone that does not have experience or knowledge of the UK. While the nursery rhyme of *Little Miss Muffet* might be known in other countries besides the UK, it is not common in the UAE and very few people know that whey is the liquid remaining after milk has been curdled and strained. "Kim is eating tea" (Flower book 2, p. 31) can also cause confusion. The British refer to dinner as *tea*, while tea outside the UK is just a hot beverage. In the textbooks, *tea time* thus refers to the time that dinner is being served, causing confusion and misunderstandings.

These issues have an influence on the mathematical content being taught as it potentially changes the outcome of the answer. For example, one example in which a caravan was being sold caused for some confusion, as a caravan in the Middle East refers to a group of nomadic people travelling through the desert and not a mobile home as in Western countries.

4.3.3. Findings

My findings on the literacy levels used in the textbooks were guided by Seidel's (1998) cyclical process of data analysis. The table on the next page was taken from my research diary and will serve as guide for the discussion to follow.

Table 4.4: Summary of data relating to literacy

	Notice things	**Collect things**	**Think about things**
Layout of the pages	The pages are busy, with very little white space	I collected many worded exercises and struggled to find simpler exercises to support the same content	The busy pages with lots of letters intimidate learners not fluent in English.
Vocabulary	Lack of definitions in both sets of textbooks	Very limited key points and definitions are described in either of the textbooks	Without a teacher to explain the concepts and vocabulary relating to mathematics, the textbook is an ineffective resource
Sentence structure	Long sentences with paragraph-style questions are used.	Every unit in both sets of books contain exercises with worded problems	Long sentences do not improve mathematical understanding, especially in an EAL classroom
Jargon	Examples and exercises contain jargon used in the UK	A vast amount of examples of jargon used exclusively in the UK were collected	With multiple nationalities in every classroom, the strong focus on the British culture is unrelatable and often makes the content misunderstood.

Source: Adopted from Seidel (1998)

A few simple findings were identified regarding the literacy levels used in the textbook. The pages in the textbooks are too busy, the sentences are too long and there are too many words on each page. As noted several times in my research diary, when learners opened the books, their first reaction varied from closing it immediately to simply exclaiming that they did not understand the work or that mathematics is too difficult. While it is important for learners to be able to apply their mathematical knowledge in word problems, it is essential that the mathematical concepts are taught and understood before applications can be made. The textbooks do not accommodate this need. The mathematical conceptual teachings are lost between long descriptions and paragraphs of explanation.

When teaching, I spent more time on addressing literacy issues than planning lessons, simply because the textbook does not allow for any literacy deficit that learners might have. An example taken from my research diary relates to the topic of surds. If learners do not know what a *surd, denominator* or *inverse function* is, they will not know how to rationalise a fraction of surds. Yet there is no definition given in the textbooks for any of these words. Very few visual aids are used to facilitate an explanation and there is an obvious lack of EAL adaptation in the textbook. The literacy levels of the learners are low and the textbook does not take this into consideration at all.

The wordplay on "Parry Hotter" (Fish book 2, p. 47) led learners to believe there was a typing error in the textbook, as noted in my research diary, and almost 20 minutes were spent explaining wordplay and British humour. Explaining to students that "Nutty Oats MuEALi" (Flower book 1, p. 169) is the name of a breakfast cereal that can only be bought in the UK, took a simple explanation and a Google search for a picture, but it took valuable time away from teaching mathematical content. The textbooks offer no insight on or description of the British lexicon for non-British readers and again the responsibility falls onto the teacher. This causes further frustration when the teacher is also not from the UK, like myself.

The jargon used in the textbook led to the examples being evaluated. This in turn led to the discovery that environmental factors also caused confusion and in the next section the environmental obstacles in the textbooks will be discussed.

4.4. Environmental factors in the textbooks

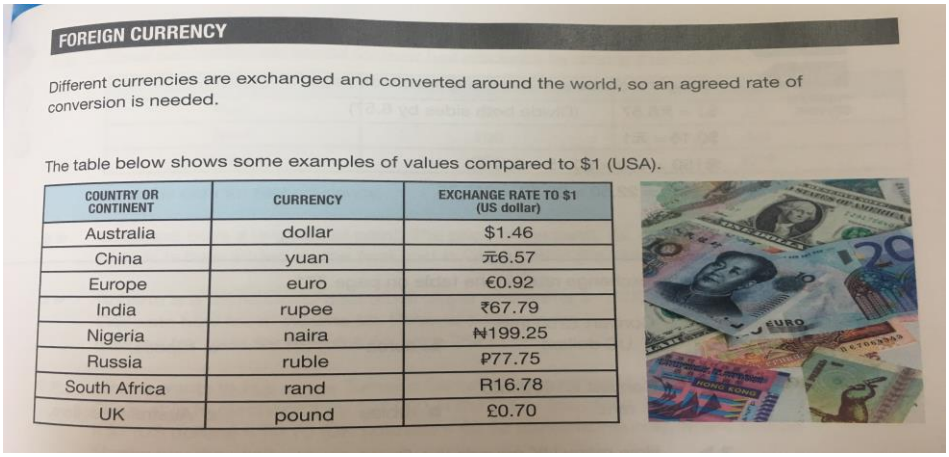
As set out by initial codes and themes (refer to Table 4.1.), the environmental factors that influenced the data analysis were the weather, geographical depictions and money matters.

4.4.1. Non-critical observations

Throughout both sets of textbooks several references to weather conditions are made. Photographs of snow and rain are used frequently and, especially in the units on data analysis, rainfall charts are used. The Flower books also contain pictures of tropical forests, beaches and deserts but the Fish books have fewer visual aids. In both sets of books, the examples used are predominantly from the UK setting and when a heat wave is described, the maximum temperatures are referred to as 25 degrees Celsius (25 °C).

Questions pertaining to smaller towns in the UK are used often, for example: "What is the probability that it will rain in Norfolk in October?" (Flower book 1, p. 368). There is no reference as to what Norfolk is or a map to show where Norfolk might be, nor is a chart or accompanying information on this question included.

Most content relating to money uses the £ (pound) symbol. Money matters are referred to throughout the textbooks and in all units. Pounds and pennies are used most frequently, with very few examples containing dollars ($) and euros (€) as currencies. There is no information on where dollars and euros are used. The only description of different currencies from around the world is to be found in Flower book 2, page 271:



FOREIGN CURRENCY

Different currencies are exchanged and converted around the world, so an agreed rate of conversion is needed.

The table below shows some examples of values compared to $1 (USA).

COUNTRY OR CONTINENT	CURRENCY	EXCHANGE RATE TO $1 (US dollar)
Australia	dollar	$1.46
China	yuan	¥6.57
Europe	euro	€0.92
India	rupee	₹67.79
Nigeria	naira	₦199.25
Russia	ruble	₽77.75
South Africa	rand	R16.78
UK	pound	£0.70

Figure 4.4: Example of different currencies from around the world (Flower book 2, p. 271)

The Australian dollar is used in the example but no explanation is given as to why it is not the same as the United States dollar (USD). In the Fish books, there is no reference whatsoever to or description of other currencies. Not once in either set of books is the currency of the UAE, namely the dirham (AED), used.

4.4.2. Critical analysis

The UAE is a desert country with temperatures ranging from 20 °C in winter to more than 55 °C in summer. Rainfall is rare and overall precipitation is less than 100 mm per year. Snow is extremely unlikely and most of the local people have never experienced snow or even heavy rainfall. The idea of constant rain is foreign to at least 30% of the learners and more than 70% of the learners had never seen or touched snow before. The vast number of examples on rain and snow renders the content entirely unrelatable.

The lack of background information on some questions and examples used in the textbooks results in misunderstandings and a basic knowledge of geography and the UK environment seems to be necessary to understand the context of some of the questions. Understanding the mathematical concept behind a question is really difficult when the context of the question cannot be grasped. Learners who do not know that Norfolk is a town in England or that a goldfinch is a type of bird will struggle to focus on the mathematical question hidden between the examples chosen to ask the question. While London might be a well-known city, smaller towns like Peterborough and Dartford are just irrelevant references for someone who has no prior knowledge of the UK. The textbooks provide no map or frame of reference when these examples are used and often confusion results in regard to what the example is referring to. One example of this confusion is a question taken from Flower book 2: “What is the probability that it will snow in Boston in January?” (Flower book 2, p. 168). Most students assumed that the question refers to Boston in the USA but when reading through the accompanying questions, it became clear that the reference was to the small town of Boston in the UK, where the probability is higher for snow in January than in Boston, USA. This resulted in a shift of focus from the mathematical concept of probability to geographical relevance.

The examples and exercises used throughout the textbooks are a clear indication of the authors’ lack of appreciation of their reader demographic. Very little effort has been made to include any examples from outside of the UK and even when attempts were made, the content is questionable.

The following picture of a camel drinking water is taken from Fish book 1, page 64:

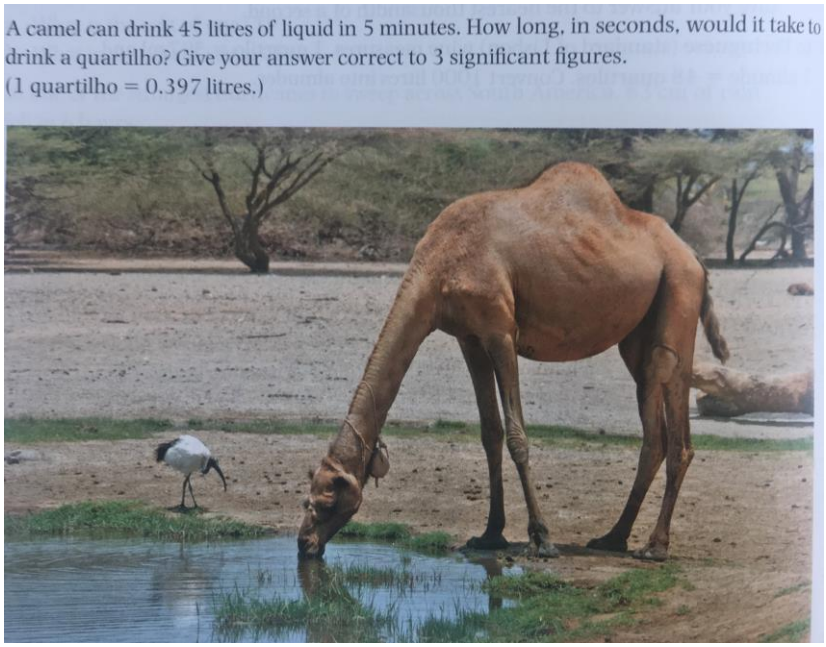


Figure 4.5: Question using a relevant and contextual example (Fish book 1, p. 64)

While the question may seem straightforward and reasonable, in the context of the UAE, where camels are abundant and well known, it led to arguments and anger. The question states that "a camel can drink 45 litres of liquid in 5 minutes". In reality, a camel can consume up to 200 litres of water in 3 minutes, a fact pointed out by several local learners in my classroom, as noted in my research diary. This led to a long discussion on camels and learners were distracted from mathematical learning. This is just another example of the impact that irrelevant examples in the textbook can have on efficient and successful learning.

4.4.3. Findings

When referring back to Seidel's (1998) cyclical process of data analysis, I was constantly amazed at how many examples from the UK are used in the textbooks without considering the international demography. The more examples I *collected*, the more examples I *noticed* and the more evident it became that the authors did not have a desert country in mind when they compiled the textbooks. Snow and rainfall are consistently referred to throughout the textbooks but extreme heat and humidity are not. This made me *think about* the importance of the chosen examples. In my research diary, I noted on several occasions that the more relevant the examples were to the learners, the quicker they grasped the mathematical concepts.

Using examples from outside the learners' frame of reference causes three things to happen:

1. Valuable lesson time is spent on explaining phenomena that are not known to the learners, for example that a vole is a type of mouse and a wren is a type of bird. Often the mathematical inquiry is lost within these explanations.
2. Learners frequently skip these questions, disregarding the mathematical question because they feel intimidated by words or things they do not understand.
3. Instead of learners relating to content, the content feels all the more foreign to them and they give up on learning mathematics altogether.

Very few learners consistently relate to the content of the textbooks, making the teacher responsible for adaptations. As a non-British teacher, I could relate to the way the learners must have felt. I did not recognise names of places or famous British people. I have never seen or touched snow before. At least I could see past the context and focus on the mathematics behind the example but learners were not necessarily able to do so. Since Arabian and Middle Eastern examples are noticeably lacking in all the textbooks, the responsibility for adapting examples fall onto teachers, making the textbooks less useful as a resource. By implication, the visual aids in the textbook become a distraction. The houses pictured are European, the rivers and valleys are unknown sights in the desert country of the UAE and snow-covered mountain ranges are absent from learners' frame of reference. Instead of focusing on the mathematical content, learners often started discussions on what snow might feel like, why the roads in pictures are not tarred but lined with cobblestones and how rivers flow through mountain ranges. This leads to classroom time being used for non-mathematical teaching, albeit not problematic if done on occasion but causing time constraints when finishing the intended mathematics curriculum before examinations start.

In the next section, the social contextualisation of the textbook in terms of the UAE will be discussed.

4.5. Social contextualisation in the textbooks

The UAE is a conservative country, governed by the laws of Islam. This leads to many rules and regulations that will not necessarily have an impact on learning in any other country but sets boundaries to the content taught in UAE classrooms. There are several culturally sensitive subjects that it is illegal to discuss in the classroom. Such religious and cultural restrictions have an impact on the examples, informative paragraphs and visual aids used in the mathematics textbooks.

4.5.1. Non-critical observations

There are obvious distractions when browsing through the textbooks for the first time. Several pictures have been purposefully covered by teachers, like the following example taken from Flower book 1, page 361.

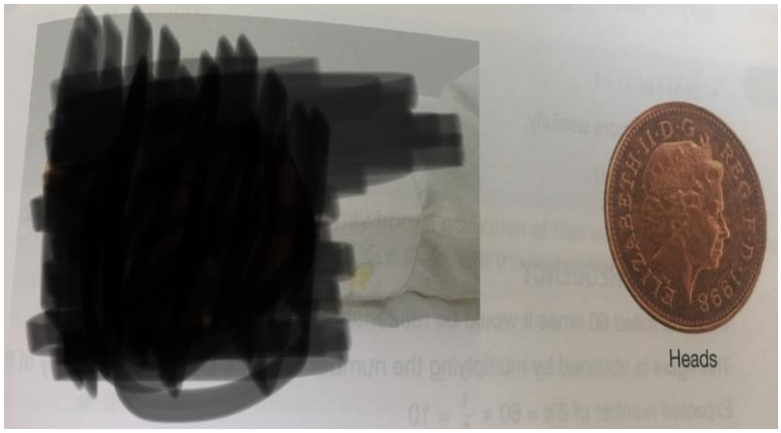


Figure 4.6: Example of covered picture from Flower book 1 (p. 361)

A black marker has been used to cover part of the picture. There is no explanation as to why the picture has been covered, which evokes an immediate sense of curiosity in the reader.

If the pictures are not covered by black marker, corrector fluid is used to cover certain parts of the picture, as can be seen in this example taken from Flower book 2, page 175:

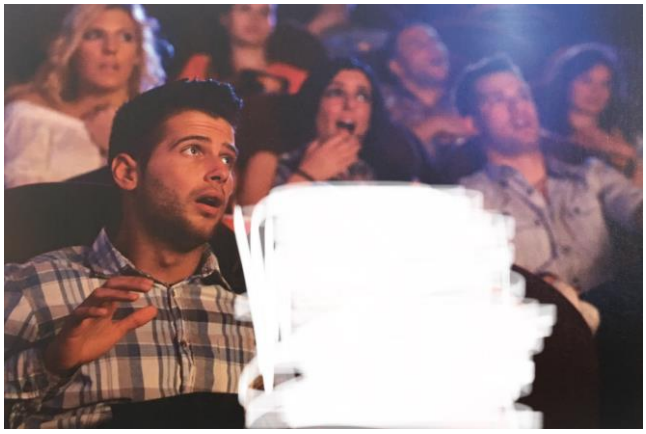


Figure 4.7: Example of covered picture from Flower book 2 (p. 175)

In some textbooks, learners have tried to uncover the pictures with no success, as this often resulted in torn pages or pages with holes in them. The covered parts of the textbook are not restricted to pictures, however. In places sentences have been erased with black marker with no reason given. While this never hinders the completion of the accompanying exercise, it is an obvious distraction from the mathematical content. Similarly, some graphs are covered with black stickers but the questions relating to the graphs are only partially covered, giving clues to the content of the graph. This renders the exercise useless. In some books, but not all, pages have been removed.

In the textbooks there are several examples and exercises that are not socially acceptable in the UAE. Women should be dressed conservatively and pictures of girls wearing swimwear on a beach setting would be deemed sinful and thus these pictures had to be covered. Any mention of Israel is illegal and reference to human classification as animals is punishable by law, leading to pages being glued together in some of the textbooks. In a unit on statistics, a graph depicting unwanted teenage pregnancies in the UK had to be torn from the textbook, as a pregnancy out of wedlock is punishable by imprisonment and deportation.

4.5.2. Critical analysis

The UAE has extremely strict rules on social conduct and swearing and the use swear words and making offensive signs are punishable by law. Showing your middle finger to someone can land you in jail, along with some hefty fines. The picture that was covered, as can be seen in figure 4.6, originally looked like this:

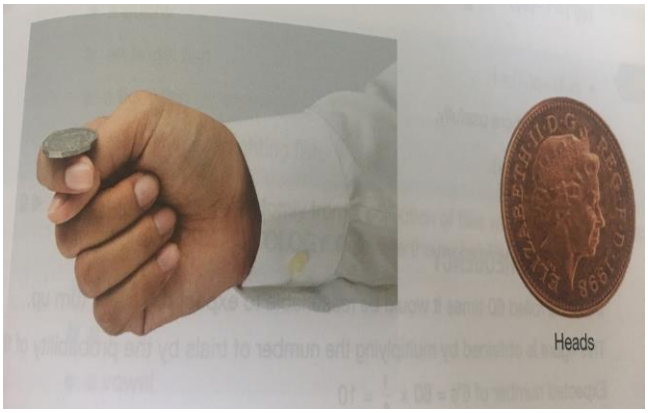


Figure 4.8: Original picture from Flower book 1 (p. 361)

While the picture would look innocent to most, in the UAE context the way the fingers cross implies a curse towards the recipient's mother and use of the gesture is therefore illegal. While this picture was supposed to show an understanding of how a coin is tossed in a unit on probability, it ended up as a distraction to the reader. Other topics that were referenced in examples and exercises in the mathematics textbooks and which had to be erased included birth control, teenage pregnancies, the idea that humans form part of the animal kingdom and pictures that do not convey accepted social conduct in the UAE.

The following picture is printed next to a word problem about students in a film club in Flower book 2, page 175 but was covered, as shown in figure 4.7.

Figure 4.9: Picture showing interaction between a male and a female (Flower book 2, p. 175)

According to the laws of Islam, it is inappropriate for males and females to display affection in public. When the two parties involved are not married, it may even be considered illegal, depending on where you are in the UAE. Therefore, this picture is not allowed and had to be removed from the books before the textbooks could be distributed to the learners.

Pages torn from books or glued together caused distraction in class and the learners' curiosity often overrides their focus on mathematical content.

4.5.3. Findings

Although the picture was not a vital component for understanding the mathematical concept of tossing a coin to determine a probability, the black marker is distracting and evokes curiosity in the reader, taking the focus away from the mathematical content. The same reasoning applies to the erased sentences and graphs. While most teaching could ideally continue, learners were distracted and their curiosity overruled curricular learning objectives. The visual aids used in textbooks should not distract learners from the content; however, the textbooks in the research sample failed in this regard. The social context of the UAE was completely disregarded when examples and pictures were chosen, even though the authors were aware that they were writing the textbook for use in countries outside the UK.

4.6. Conclusion

The criteria in qualitative research are expansive and subjective in terms of the paradigms, theories and methodologies employed (Silverman, 2013; Creswell, 2013; Maree, 2016). After considering Devetak and Vogrine (2013), Johansson (2005), Wen-Cheng (2010), Swanepoel (2014) and Henning (1996), I derived a personalised list of criteria to guide my thematic analysis. The following table contains this set of criteria, as set out in Chapter 3, together with a summative description of the data analysed:

Table 4.5: Summative interpretation from set criteria

Criteria	Fish books	Flower books
The structure is clear and transparent: learners can find their way easily in the textbook easily.	An outline of the course structure appears on the first few pages with short descriptions of the content. However, if the learner does not know what category or unit the work they are looking for falls into, they will have trouble finding the information.	Apart from the course structure, which is very similar to that of the Fish books, there is also a page that shows learners how to use the book and even where to find additional resources.
Technical guidance is considered: all technical details are correct, including correctness of content, copyright is not infringed and proofreading has been done.	Since Pearson is a leading publisher of school textbooks, the technical requirements have all been met in both sets of textbooks.	

Criteria	Fish books	Flower books
The content is consistent with the learning objectives.	There is an obvious lack of learning objectives in the book and no reference to levels is made. This is strange as learners are consistently required to know what their current level is and what they are working towards.	At the beginning of each unit, the learning objectives are stipulated and the level of the questions is indicated next to the exercises. This makes it easier for students to navigate according to their own ability.
The content is didactically adequate: the needs and abilities of learners have been taken into consideration when adapting the content of the textbook.	Since there is no reference to levels in the textbook, differentiation is nearly impossible and learners have no indication of the ability required before an exercise is started.	Learners can see the level of every exercise, which helps them guide their own progress. The content is not friendly for the lower ability students, however, as most exercises and examples focus on levels 5-9.
Text is linguistically appropriate: unknown or difficult words are defined and explained.	This is especially not the case when it comes to literacy. The vocabulary level is too advanced and the lack of definitions makes the book difficult to depend on as a resource.	The lack of definitions in every unit makes it more difficult for EAL learners. There is a glossary at the end of the book but the definitions are long and difficult to understand.

Criteria	Fish books	Flower books
Visual aids are relevant and appropriate: pictures are suitable for learners and add value to the content, while not being distracting.	The few pictures that are included in the book are not always relevant. When the pictures are not suitable for use in the UAE, they are erased using a black marker, thus distracting learners.	There is at least one picture on every second page in these books, but their relevance is often questionable. The pictures are not always helpful, thus tending to distract. Some pictures had to be covered with black marker as they were not suitable for the UAE context.

In the next chapter the data will be evaluated with reference to the literature review and the conceptual framework. Subsequently, recommendations will be made as to how the textbooks may be adapted to be more useful resources in the international mathematics classroom.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1. Introduction

The initial aim of this research study was to determine how British mathematics textbooks should be adapted to consider the context of international secondary schools in Abu Dhabi. To answer this question, a contextual understanding of the UAE and the textbooks used as resources in the classrooms is necessary. While Chapter 2 provided insight on the culture and context of the UAE, the textbooks and their content were highlighted in Chapter 4. Throughout Chapter 4 a non-critical reading of the data was followed by critical observations and a discussion of the findings. In this chapter I will marry the theoretical literature from Chapter 2 with the practical findings from Chapter 4. A formal evaluation of each section will be followed by practical recommendations.

5.2. IGCSE curriculum and the levelling system

Tabari (2014) is adamant that the context of learning is essential when delivering content. Swanepoel (2010) and Johansson (2006) agree, stating that without contextual understanding of concepts, mathematic teaching cannot be maximised. In the developing classroom, as described by Wen-Cheng (2010), the textbook is still considered an invaluable resource and Rezat (2009) adds that for the textbook to be effective it needs to be adapted for the specific requirements of the classroom. In developing classrooms, textbooks serve the purpose of planning and preparing lessons and the learners are frequently actively engaged with them (Rezat, 2009). Love and Pimm (1996) argue that textbooks should never be used in isolation but Shellard and Moyer (2002) point out that time constraints often prevent teachers from adapting the textbook on a regular basis. The ideal textbook should be sufficient when used by the learners on their own (Wen-Cheng, 2010; Rezat, 2009). This highlights the importance of my focus on the layout, structure and methods used in the textbooks when covering the content. While this section might not address one of the secondary research questions directly, it is applicable in the attempt to answer the primary research question:

How should British mathematics textbooks be adapted to consider the context of international secondary schools in Abu Dhabi?

The following table is taken from my research diary and proved to be a very useful tool for guiding my evaluation in a structured way.

Table 5.1: Summary of the alignment of the literature to the practical findings on the curriculum structure and levelling system

	Critical observations and findings	Evaluation from a literary perspective	Recommendations
Navigation through the textbook	Navigation is possible with a clear layout in both sets of books but still not easy for the learners to follow.	Content should be arranged logically with clear descriptions of each unit.	Cluster similar topics together to avoid confusion and examples could serve as a clear indication of learning objectives in each unit.
Structure and layout of the units	The start of each unit is not always relevant to the content being offered in that unit	For EAL learners, content should be chosen purposefully and with the clear intention to avoid confusion.	A short reflection on the prior knowledge needed to complete this unit would be useful.
How to use the textbook	At the beginning of both sets of books a detailed description of "how to use the textbook" is given.	Giving instructions once is not sufficient for EAL learners. This should be repeated throughout the textbooks.	At the start of each unit a small textbox could be included to guide the learners through the specific unit
Indication of levels	The Fish books make no reference to levels, while the Flower books focus on higher-level questions.	Learners should be consistently aware of what level they are working at.	Levels should be prioritised throughout the textbooks, with questions starting at the lower levels and scaffolded into higher tiers.

	Critical observations and findings	Evaluation from a literary perspective	Recommendations
Learning objectives	Learning objectives in the Fish books are not always clearly indicated. In the Flower books every unit starts with the learning objectives.	Providing learning objectives at the beginning of every unit is sufficient when working with first language speakers, but when teaching EAL learners it would be more effective to state the learning objectives at the beginning of every exercise.	Spread the learning objectives throughout the units instead of listing them at the beginning of the unit.
Visual aids	The Flower books have more pictures and graphs than the Fish books. However, the visual aids are not always relevant to the content or suited to the teaching context.	Visual aids should not distract from the content. They should assist in understanding the content.	More visual aids than are currently used should be included in the Fish books. Flower books should include more effective and specific visual aids than is currently the case.

The content of the table will be described in more detail in the following sections.

5.2.1. Evaluation

While navigating the textbook is possible, in reality it is not easy. Learners struggled to find their way through topics and course content, as the order of the topics is not easy to understand. When dealing with EAL learners, it is especially important that the structure of the textbook is easy and understandable (Mohamed & Kumari, 2007). Johansson (2006) and Rezat (2009) reason that when the content of the book is structured logically, with brief and clear descriptions of the content being covered in each unit, EAL learners will use the book with more confidence. Wen-Cheng (2010) and Wellington and Osborne (2001) suggest that the ideal textbook for EAL learners would comprise a content page with examples of what is to be covered in every unit. This would allow learners to see a practical example of the content that is being covered, as opposed to only reading a descriptive sentence on it.

While every unit starts with a bright caption and picture, the introduction to a new unit is often irrelevant and not suitable for the content being covered. While information regarding the number nine might be interesting for the advanced, English first language speaking learner, the paragraph of information is nothing but a distraction and discouragement for the EAL learner. Crawford (2003) and Wilson (1997) point out that textbooks formulated for higher year groups, specifically written with an examination in mind, should preferably steer clear of all irrelevant information. Swanepoel (2010) adds that this is especially true when dealing with EAL learners.

The preface in both sets of textbooks, setting out how to use the textbook, may seem adequate but in reality these pages were completely disregarded by the learners. Wen-Cheng (2010) suggests that guidance on the use of any textbook should be done consistently throughout book. This will mean that learners are constantly guided on how to work with the content, instead of giving them the information once and then assuming they will remember it throughout the year (Swanepoel, 2010; Wen-Cheng, 2010).

Johansson (2006) points out that levels in a textbook are especially important in a classroom where the medium of instruction is not the first language of most of the learners. The levels guide learners in a simple way to stay on their academic track and ensure that sufficient progress is made throughout the course (Swanepoel, 2010; Johansson, 2006). Wen-Cheng (2010) adds that in developing classrooms the levels indicated in the textbook can have a

significant impact on learner attainment, as learners are constantly reminded of their progress and challenged to improve individually.

From my research diary I noted that a lot of time was spent on guiding learners towards their target levels and I even had some learners mark the levels in the textbooks for referencing at a time when I would not be available to them. If learners are constantly aware of their level and progress, they gain confidence in the subject and they feel motivated to improve, without being singled out in class or their level being made public in the classroom environment (Wen-Cheng, 2010; Tyson, 1997; Al Falasi, 2004).

The learning objective in advanced classes might not serve as the main guidance for learners (Wen-Cheng, 2010), but in developing classrooms where language barriers often hinder academic progress, the learning outcomes are significantly more essential (Swanepoel 2010; Wen-Cheng, 2010; Rezat, 2009). Learning outcomes should be constantly considered and not merely referred to once at the start of the unit, as learners seldom navigate back on their own (Wellington & Osborne, 2001). Learning objectives not only provide guidance on curriculum content but for EAL learners the learning objectives become a "safety net of security and known expectation" (Wen-Cheng, 2010:5).

While visual aids in textbooks are a necessity when dealing with EAL learners (Swanepoel, 2010: Wen-Cheng, 2010), the choice of visual aid can determine the success of a textbook (Johansson, 2006; Haggarty, 2001; Shellard & Moyer, 2002). When choosing visual aids, a guiding assumption would be to determine whether the picture or graph assists in understanding of the content (Wellington & Osborne, 2001). Accordingly, the visual aids should improve the learners' conceptual understanding and not hinder their grasp of the concept by acting as a distraction (Rezat, 2009; Haggarty, 2001; Johansson, 2006; Swanepoel, 2010). The pictures, figures and graphs used in both sets of textbooks often ended up being irrelevant to the learners' contextual understanding, as noted in my research diary.

The overall effectiveness of the textbook can be improved by adapting the textbook structurally. Recommendations for these adaptations are discussed in the next section.

5.2.2. Recommendations

The textbooks consists of sufficient content for exam preparation but the layout of the textbooks makes navigation difficult. If the topics are regrouped so that all units follow each other logically, learners would feel more confident in using the textbooks on their own, without the help and guidance of the teacher. This would make the textbooks a more useful resource at home, where the teacher is not present to assist. For example, in striving for the ideal textbook, Wellington and Osborne (2001) suggest that a possibility is to add an example of the content being covered on the content page.

At the start of every unit, the topic should be communicated clearly and accompanied by sufficient examples of what is expected of the learners. Instead of irrelevant paragraphs of information, there should be a focus on the prior knowledge required for the completion of the specific unit. Davis (2009) suggests a short checklist to guide learners on their educational journey.

When using the textbooks in class, the learners had to be constant guided on how to use the textbook properly. Small notes in the margins or textboxes could easily be used to guide learners on how to use the textbook effectively. Most exercises do not give formal instructions, leaving learners feeling unsure about what is expected from them. Al Falasi (2004) aptly points out that learners in the UAE are not given sufficient independent learning skills and if the textbooks are adequately adapted, their independent learning could improve without any extra effort by the teachers. This would not only benefit the learners but also save the teachers time (Al Falasi, 2004; Snyder, 2014).

Levels should be added and used consistently throughout the textbooks. Questions should be scaffolded according to the levels and arranged from low to high to make progress possible and attainable. When levels are combined with learning objectives, the effectiveness of the textbook is improved and it would thus prove to be a more useful resource, not only in class but also at home (Crawford, 2003; Johansson, 2006).

When dealing with EAL learners, the content of the book should focus on the learning objectives and attaining the outcomes. It would be a relatively easy task to spread the list of learning outcomes at the start of the unit throughout the unit, thus ensuring that learners will know exactly what learning objective links to the example or exercise given.

The visual aids used in the textbooks could be dramatically improved if the pictures were more relevant to the content being covered and if the UAE context were considered. This context will be discussed in more detail in the section on social context (see § 5.5). The adaptation of the textbook for EAL learners would not hinder the progress of first language speakers, but the benefits for the majority of classrooms in the UAE would be significant. Making the recommended changes to the textbook would not divert attention away from the content to be delivered but would rather secure a more focused resource for use in class and at home, something Wellington and Osborne (2001:4–5) mention as an essential part of the "perfect" textbook.

5.3. Literacy levels

Ahmed (2010), Khalaf (2009) and Tabari (2014) report that the English levels of learners are theoretically improving throughout the UAE but the reality is that learners are still struggling in English classrooms. Rosenthal (2016) and Johansson (2006) suggest that the use of an effective textbook could alleviate the pressure of literacy attainment in the mathematics classroom. The textbook is often the first place a learner goes for assistance (Haylock, 1991) and Abosalem's (2016) research proves that this is exactly the case in the UAE, where learners prefer the use of a textbook to photocopied notes. Mathematics has a language of its own (Johansson, 2006) and without an acceptable level of English proficiency, the mathematical content simply cannot be taught (Alzahrani, 2014; Ghamri, 2012; Abosalem, 2016).

Additionally, the textbook becomes an invaluable resource for EAL learners at home, when the English speaking teacher is not available to explain difficult words or concepts (Ghamri, 2012l Al Falasi, 2004: Khalaf, 2009). Wen-Cheng (2010) adds that the literacy level of a learner in a developing classroom might not be such a great barrier if there is an effective textbook to guide that learners in accessing definitions and examples in a language they can understand. In this section I aim to answer the first secondary research question:

How can the literacy levels in British mathematics textbooks be adapted to consider the literacy standards in the international secondary schools in Abu Dhabi?

The following table summarises my critical observations and findings from Chapter 4 and serves as a guiding structure for evaluating the data in this chapter.

Table 5.2: Summary of the alignment of the literature to the practical findings on the literacy levels in the textbooks

	Critical observations and findings	Evaluation from a literary perspective	Recommendations
Definitions in textbooks	There is a lack of definitions in both sets of textbooks, but a short glossary can be found at the back of the Flower books.	Simple definitions of mathematical concepts and instructive language are essential in EAL textbooks	Use multiliteracies to describe more difficult concepts; consistency in defining mathematical concepts; reminders of what is expected when instructions are given
Vocabulary and sentence structure	Complex words, long sentences and paragraphs of information are used frequently in the textbooks.	Short sentences with simple words help improve confidence and aid motivation.	Shorten sentences and start every sentence on a new line. Simplify words and give definitions when required.
Layout of pages	Pages are crammed with information and very little white space is left. Mainly single spacing is used. The use of colour and different font sizes is effective.	Margins are not essential in textbooks, but leaving white space alleviates pressure on low attainers. 1.5 and double line spacing are more effective between questions.	Adapting line spacing is a simple way of improving the layout of a textbook. More space between questions would improve the cramped appearance of the text, making the textbooks a more effective resource.
Multiliteracies and visual aids	Very few visual aids are used to improve the understanding of definitions and concepts.	Multiliteracies have taught us that describing ideas and teaching concepts can be done in a variety of ways and with great success, especially in EAL classrooms.	Visual aids can serve a more useful purpose when chosen carefully and the placement of visual aids is contextually considered.

A detailed discussion of the information in the table will follow in the next section.

5.3.1. Evaluation

The lack of definitions in both sets of textbooks would be a cause for concern even in first language classrooms (Wen-Cheng, 2010; Ghamri, 2012) as lack of definitions can hinder progress at any level of mathematics (Swanepoel, 2010). A glossary at the back of the book might be sufficient for learners confident in navigating the textbook and not discouraged by pages filled with words, but EAL learners are often intimidated by pages crammed with words (Wen-Cheng, 2010) and therefore a glossary alone will be insufficient in EAL classrooms (Wellington & Osborne, 2001). Defining difficult vocabulary is essential for conceptual understanding in mathematics (Johansson, 2006) and the research done by Mohammad and Kumari (2007) highlights the importance of definitions for EAL learners, as definitions guide them to understand the content being taught more effectively. In the absence of basic definitions used consistently throughout the textbooks, the effectiveness of the textbook as a resource declines significantly (Mohammad and Kumari, 2007; Haggarty, 2001; Ghamri, 2012).

According to Wen-Cheng (2010) and Johansson (2006), textbooks need to be linguistically adapted to suit the literacy levels of the learners. This evidently did not happen in either of the sets of textbooks from the research sample. The long sentences, paragraphs of information and pages crammed with words intimidate learners and serve to discourage initial learning (Rezat, 2009; Swanepoel, 2010; Ghamri, 2012). Wellington and Osborne (2001) describe the perfect textbook for EAL learners as one where simple words explain difficult concepts, something the current textbooks fail to do.

The lack of white space makes the pages look extremely busy, crowded and cramped, something that any textbook should steer clear of (Johansson, 2006; Rezat, 2009; Henning, 1996). EAL learners often feel discouraged when confronted with a page filled to the edges with words (Ghamri, 2012) and single line spacing should be avoided in all textbooks (Swanepoel, 2010; Wen-Cheng, 2010; Rezat, 2009). Wellington and Osborne (2001) suggest that textbooks use no smaller than 1.5 line spacing, with a clear font and adequate margins on every page. Ideally, descriptions, definitions and key concepts should be added in additional textboxes and used with colour (Alzahrani, 2014; Swanepoel, 2010).

In both sets of textbooks, the relevancy of the visual aids is questionable. Multiliteracies teaches that visual aids are an elementary method for adding value to contextual understanding

(NLG, 1996) and that when visual aids are chosen purposefully and used correctly in textbooks, it can be more effective than long definitions and descriptions, especially in EAL and developing classrooms (Wen-Cheng, 2010; NLG, 1996; Jewitt, 2014). Visual aids can be used to not only address literacy misconceptions and for clarification but also to make content contextually more relevant, reliable and trustworthy for learners (Bond, 2000; Cope & Kalantzis, 2009; Selber, 2009).

5.3.2. Recommendations

Adding definitions in every unit would be an easy way to improve the textbook but an exponential improvement would result from employing concepts from multiliteracies (NLG, 1996). For EAL learners, while definitions do not have to be formulated using more words, pictures and drawing could easily be used to describe words like "ascending" and "descending" for example (Research diary, 2018:32). Since the textbooks must ideally be suitable for home use where no teacher is present, constant reminders of what is expected when instructions are given may be useful not only for completing the current exercises but also for exam preparation. This forms part of the jargon that is unique to mathematics and needs to be explained in order to maximise the effectiveness of the ideal textbook (Wellington & Osborne, 2001).

Further, shorter sentences would dramatically improve the usefulness of the word problems in the textbooks. I have spent countless hours simplifying sentences for better understanding, something the textbook could have done without affecting the curriculum content. Starting every sentence on a new line is also something that is frequently suggested in the literature on improving textbooks for EAL use (Wen-Cheng, 2010; Swanepoel, 2010; Ghamri, 2012; Wellington & Osborne, 2001).

Adapting the line spacing and leaving more white space between questions are simple ways to improve the effectiveness of the textbook. In this way, low attainment or EAL learners will not be intimidated by overcrowded pages and the content would remain the focus of each exercise.

Using basic examples from multiliteracies, as suggested by NLG (1996), the visual aids in both sets of textbooks could be improved by simply choosing more relevant pictures and graphs. Most pictures are so far removed from the learner's world that they become a distraction, rather than improving the focus on contextual understanding.

5.4. Environmental factors

The environment in the UAE differs greatly from that of the UK and while this may seem like a moot point when writing textbooks, the literature proves otherwise. According to Swanepoel (2010), Johansson (2006), Ghamri (2012) and Wen-Cheng (2010), the environmental examples used in textbooks can have a negative effect on the understanding of content by learners if too far removed from their reality. Using environmental examples is often the way textbook authors make theoretical knowledge applicable in real-life situations (Johansson, 2006) but if the examples are not relatable for the learners, they become ineffective and often cause distractions (Wen-Cheng, 2010).

In this section I aim to answer the second secondary research question:

How can the content of the British mathematics textbooks be adapted to consider the environmental differences of Abu Dhabi?

The following table summarises my critical observations and findings from Chapter 4 and serves as guiding structure for evaluating the data in this unit relating to environmental factors.

Table 5.3: Summary of the alignment of the literature with the practical findings on the environmental references in the textbook versus the learners' environmental context

	Critical observations and findings	Evaluation from a literary perspective	Recommendations
The weather	Several references to snow, temperatures below zero and rainfall are made, with most learners having no context for these issues.	If learners have no grasp on the contextual references and examples, they will struggle with conceptual understanding.	Replace examples from the UK with more relevant examples from the UAE.
Money matters	While currencies form an integral part in several units in the curriculum, world currencies are often ignored and the focus remains on dollars and pounds.	If examples are neither tangible nor relevant from a learner's perspective, the conceptual understanding will be significantly more difficult to grasp.	Make references to dirhams, rupees and other Middle Eastern currencies. This would not hinder progress but encourage understanding.
People and places	Famous British people and British towns are often referred to in exercises and examples, with few learners grasping the context of these examples.	When contextualisation in textbooks fails to understand the learners' perspective, the effectiveness of textbook content is significantly reduced.	The examples could be adapted to the UAE context without changing the content of the curriculum developed in the textbook.

A detailed discussion of the information in the table will follow in the next section.

5.4.1. Evaluation

Mathematics encompasses more than simply knowledge of the manipulation of numbers, shapes and variables within an algebraic context (Johansson, 2006; Ghamri, 2012; Henning, 1996). When working with directed numbers, temperatures below zero are often used in a way that is similar to a traditional number line (Wen-Cheng, 2010; Shellard & Moyer, 2012). However, if learners fail to grasp the concept of temperatures below zero, simply because they have never experienced them, the whole mathematical concept of a number line being similar to a thermometer is deemed ineffective as teaching practice (Shellard & Moyer, 2012; Snyder, 2014). In the same realm of reasoning, pictures of snowfall will be more of a distraction than an additional aid if learners have no frame of reference for this weather condition (Wen-Cheng, 2010). Wellington and Osborne (2001) explain that textbooks should provide sufficient contextual understanding for learners so that the content can be made relevant to their understanding and tangible for them. Ahmed (2010) and Mohammad and Kumari (2007) add that textbooks that seem far removed from the learners' world and reality are often disregarded by them.

Financial concepts, money matters and currency exchange rates are all topics required by the IGCSE curriculum (*British Council in the UAE*, 2017). Although the textbook covers these topics adequately, reference is only made to pounds, euros and dollars. Snyder (2014) mentions the lack of adaptation of these specific topics in all mathematics textbooks and they way many teachers frequently opt to simply skip these topics because they are not relevant for the UAE context. Ahmed (2010) reckons that if the UAE dirham were incorporated in these units, the content would be more interesting, relevant and relatable for the learners, leading to more effective teaching and learning from the textbook. While the Flower books do refer to other currencies from around the world, there is an absence of these explanations in the Fish books. In my research diary, I noted that I had to explain the difference between the Australian, Canadian and American dollar and how they relate to the local dirham several times. In the international classroom, learners are eager to share the currencies of their home countries and if they could see some more examples of a variety of currencies in the textbook, they would feel the content to be more personally adapted to their own learning, as suggested by Shellard and Moyer (2012).

The textbooks make use of several examples of famous British people and frequently mention British towns in examples and exercises. While most learners might recognise the likes of

James Bond, Mr Bean and Sherlock Holmes, some lesser known actors and musicians are merely strange names to the learners, causing confusion in class, as noted in my research diary. Davis (2009) mentions that if the people referred to in textbooks are strangers to the learners, or the learners are given no additional information on them, the content will often be lost in the proverbial translation. The same principle applies when referring to places. Wen-Cheng (2010) adds that if the places mentioned in the textbook are strange to the learners' reality, the textbook will seem like a stranger in the midst of learning, making the textbooks far less effective. Crawford (2003) suggests that all textbooks, especially those used in EAL classrooms, be made as real and relevant as possible for the learners, without taking away any of the curriculum content.

5.4.2. Recommendations

Without changing the curriculum content of the textbook, the examples and exercises can be adapted to be more relevant to the understanding of the learners' reality. If temperatures below zero are used, some information about this weather condition can be shared. Learners with experience of snow and cold weather could be encouraged to share their experiences in class and this could be done in the textbook without affecting the mathematical content to be taught. However, including more examples of extreme heat would be more relevant and contextually suitable for learners. Rainfall graphs should not be omitted but the content of these graphs could be amended to include rainfall in Middle Eastern countries, instead of focusing only on small towns in the UK.

The conceptual understanding of pounds, euros and dollars is important but disregarding the local currency and other currencies from around the world does not help to involve learners in the textbook. By adding more variations of currencies, the textbook would be figuratively speak more directly to the learners.

Adapting the textbook every time for more suitable learning in terms of people, places and the weather is not only time consuming but also renders the textbook less effective than it may otherwise be. By exchanging unknown towns with familiar regions, strange people with known faces and unrelatable weather conditions with examples from the Middle East, the content of the textbook could be used more effectively and consistently.

5.5. Social context

In this section I aim to answer the third secondary research question:

How can British mathematics textbooks be adapted to consider the social context of the UAE?

The social context of the UAE resides in the religious beliefs of Islam, making the rules conservative. Tabari's (2014) research on how the education sector has to be constantly monitored to ensure that the conservative rules are implemented is detailed and relevant in this regard. The social context of the UAE has influenced the textbook in two thematic senses, that is, religiously and culturally. Often these two themes are intertwined but for structural purposes I decided to distinguish between them throughout the data analysis and data evaluation processes. The following table summarises my critical observations and findings from Chapter 4 and serves as guiding structure for evaluating the data in this chapter.

Table 5.4: Summary of the alignment of the literature to the practical findings on the social references in the textbook versus the learners' social context

	Critical observations and findings	**Evaluation from a literary perspective**	**Recommendations**
Religious restrictions and cultural sensitivity	Certain pictures and graphs had to be covered or removed.	Covering any picture or part of a page in a textbook is distracting for learners trying to focus on the content.	Use conservative pictures and examples that are accepted in all religions.

A detailed discussion of the information in the table will follow in the next section.

5.5.1. Evaluation

Ghamri (2012), Tabari (2014), Khalaf (2009) and Alzahrani (2014) all note that the strict and conservative rules of UAE society have a great impact on the education sector, even in international private schools. Topics like birth control, dating members of the opposite sex and even homosexuality may be acceptable education practice in classrooms throughout America and Europe, especially in Year 11, but in the UAE this will result in the teacher's contract being terminated with immediate effect (Ahmed, 2010; Ghamri, 2012). The government requires careful scrutinising of textbooks before they are handed to learners (Tabari, 2014; Ghamri, 2012) and every social, cultural, religious and political reference that is unsuitable for the UAE context has to be removed (Khalaf, 2009; Snyder, 2014; Tabari, 2014). This leads to textbooks with sections obscured by black marker pens, corrector fluid and dark stickers and sometimes entire pages are removed. The effect of these deletions are threefold: some content is taken away from learners, learners are left curious and distracted, and valuable teaching time is spent on creating new resources (Snyder, 2014; Tabari, 2014; Khalaf, 2009; Ghamri, 2012; Alzahrani, 2014).

In 1986, Apple noted that textbooks should never be a distraction for learners, a finding that was supported by Tabari's research in 2014, thus indicating that it is still valid. Learners should remain focused on academic attainment (Ahmed, 2010) and the ideal textbook guides this focus (Wellington & Osborne, 2001). Where the textbook might sometimes fail, the teacher should be present to fill the gaps (Shellard & Moyer, 2012) but when the textbook has to be partially covered and pages torn from the book, the textbook becomes a hindrance to achieving the educational goals (Ahmed, 2010; Tabari, 2014; Khalaf, 2009).

The textbooks already lack visual aids and the fact that some pictures and graphs then have to be covered causes frustration and distraction, as noted several times in my research diary.

5.5.2. Recommendations

The examples, exercises and pictures used throughout both sets of textbooks should be chosen by considering the UAE context. Boys and girls cannot appear together in the same picture, especially when inappropriately attired and touching each other. References to terrorism, rape, Israel, birth control and genocide should be substituted with more conservative examples. This would not take away from the content being delivered but it would make the textbooks a more useful and effective resource.

Throughout the research journey, a few unexpected findings came to light. The assumption that the textbooks were written specifically for the IGCSE curriculum was sufficiently justified: the title of both sets of books, as well as the preface give clear indications that the textbooks may be used in preparation for the final examination. While it was found that the textbooks had not been adequately adapted to the UAE context, the exam papers by contrast had significantly adapted for use by international EAL learners. In exam papers, questions include examples from desert countries, skyscrapers like the Burj Khalifa in Dubai and currencies from around the world, including India and Pakistan. Although the textbooks claim to be resources for preparing learners for these IGCSE, if they are compared to the content and context of the exam papers, the textbooks are obviously failing in their quest.

When looking at all the data in its entirety, I realised that throughout the textbooks, not one single picture or figure can be seen depicting any Middle Eastern learner. There is no girl wearing a head scarf, hijab, shayla or abaya. There is no boy wearing a kandura or gutra. While there are several pictures of Caucasian teenagers, there is one picture of a group of Asian boys but not one picture of any dark-skinned person, regardless of race, culture, gender or age. This seems strange as there is a large community of Muslims and a variety of races residing in the UK. One cannot help but wonder if this omission was done on purpose or if it was simply a careless oversight.

Adaptations to the textbooks could be done simply, without any major economic implications. The textbooks could be adapted to address so many issues in the Middle East without hindering the learners' academic progress. As lots of visual aids are distracting for the learners, this could be easily overcome by simply replacing the current visual aids with more culturally and religiously sensitive ones. British international schools throughout the Middle East would surely benefit from an adapted mathematics textbook.

5.6. Conclusion

Every piece of information gathered, analysed, evaluated and considered over the past two academic years has been aimed at answering the primary research question:

How should British mathematics textbooks be adapted to consider the context of international secondary schools in Abu Dhabi?

The secondary questions have structured the thought processes applied in this study and, hence, the primary question can also be answered with reference to the secondary questions. In order to be considered as a truly effective resource, the British mathematics textbooks should be adapted in several ways:

Firstly, the layout and structure of the textbook should be simplified so that EAL learners can navigate the book easily. Using levels and learning objectives more consistently would also alleviate the pressure on the teacher to provide this information.

Secondly, the literacy levels need to lowered. More definitions should be given throughout the textbook and vocabulary should be simplified to accommodate EAL learners, without hindering the academic progress of the more able first language speakers.

Thirdly, all examples should be adapted to be more relevant and real for learners, as well as socially acceptable in accordance with UAE standards.

The mathematics textbooks used in international secondary schools in Abu Dhabi are not effective resources nor are they contextually relevant. By adapting these textbooks, teachers would gain a more valuable resource and save time on planning and adapting lessons from the textbook. Learners have very limited resources to study from at home and an adapted textbook would fill this gap in the educational sphere of teaching for an international curriculum in a foreign country.

I paraphrase the research of Shellard and Moyer (2012), Henning (1996) and NLG (1996) to summarise my conclusion:

Mathematical problems cannot be deciphered, understood, comprehended or made a learner's own if there is no prior knowledge of relevance to make the content real. If we can look beyond the words to the meanings and value of content in every textbook and we plan concisely to adapt the textbooks to encompass the full curriculum within the context of the learner, then, and only then will we truly have a significant, effective resource for both learner and teacher.

6. LIST OF REFERENCES

Abosalem, Y. 2016. Analysing and comparing the two grade 10 Mathematics textbooks versions used in Abu Dhabi Schools. *Pedagogical Research*, 1(1): 13–25. Khalifa University, UAE.

Al Falasi, H.G. 2004. UAE English skills: A textbook evaluation. A thesis in teaching English to speakers of other languages, submitted in fulfilment of the requirements for the degree Master of Arts. American University of Sharjah: College of Arts and Sciences, Sharjah, UAE.

Al Qaydi, S. 2016. The Status and Prospects for Agriculture in the United Arab Emirates and their Potential to Contribute to Food Security. *Journal of Basic & Applied Sciences,* 2016: 12, 155-163.

Alzahrani, M.R.R. 2014. An evaluation of the questions in the mathematics textbooks of Saudi Arabian secondary schools. Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy. University of Strathclyde: Faculty of Humanities and Social Sciences, School of Education, Glasgow.

Anstey, M. & Bull, G. 2006. *Teaching and learning multiliteracies: Changing times, changing literacies.* Australia: International Reading Association.

Apple, M.W. 1986. *Teachers and texts: A political economy of class and gender relations in education.* New York: Routledge & Kegan.

Babbie, E. & Mouton, J. 2001. *The practice of social research*. Cape Town: Oxford University Press.

Baškarada, S. 2014. Qualitative case study guidelines. *The Qualitative Report*, 19(40): 1–25.

Bernier, M.J. 1996. Establishing the psychometric properties of a scale for evaluating quality in printed educational materials. *Patient Education and Counselling*, 29: 283–299.

Blaikie, N. 2000. *Designing social research: the logic of anticipation.* Massachusetts: Blackwell.

Blommaert, J. & Bulcaen, C. 2000. Critical discourse analysis. *Annual Review of Anthropology*, 29: 447–466

Bohman, J. 1991. *New philosophy of social science: Problems of indeterminacy.* Cambridge, MA: MIT Press.

Bond, D. 2000. Negotiating a pedagogy of multiliteracies: The communication curriculum in a South African management development programme. In B. Cope & M. Kalantzis (Eds) *Multiliteracies: Literacy learning and the design of social futures.* London: Routledge Taylor & Francis Group.

BonJour, L. 2002. *Epistemology: Classic problems and contemporary responses.* Lanham, MD: Rowman & Littlefield.

Braun, V. & Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77-10

British Council in the UAE. Updated March 2017. Viewed on 29 April 2017. https://www.britishcouncil.ae/en

Bubner, R. 2003. *The innovations of idealism.* Cambridge: Cambridge University Press.

Carr, W. 2003. Educational research and its histories. In P. Sikes, J. Nixon, & W. Carr (Eds.) *The moral foundations of educational research*. Maidenhead, UK: Open University Press, 6–17.

Carrow, S. M. A. 1957. Linguistic functioning of bilingual and monolingual children. *Journal of Speech and Hearing Disorders*, 22: 371-380.

Castell, S., Luke, A. & Luke, C. (Eds). 1989. *Language, authority and criticism: Readings on the school textbook.* London: Falmer Press.

Chevallard, Y. 1985. *La Transposition Didactique. Du savoir savant au savoir enseigné.* Grenoble: Pensées sauvages.

Churchouse, R.F., Cornu, B., Ershov, A.P., Howson, A.G., Kahane, J.P. & Van Lint, J.H. 1984. The influence of computers and informatics on Mathematics and its teaching. An ICMI Discussion Document. *L'Eneignement Mathematique*, 30: 161–172.

Cohen, L., Manion, L. & Morrison, K. 2007. *Research methods in education*, 6th ed. London: Routledge.

Cope, B. & Kalatzis, M. (Eds). 2003. *Multiliteracies: Literacy learning and the design of social futures.* London: Routledge Taylor & Francis Group.

Cope, B. & Kalantzis, M. 2009. "Multiliteracies": New literacies, new learning. *Pedagogies: An International Journal*, 4(3): 164–195.

Cope, B. & Kalantzis, M. 2015. The things you do to know: An introduction to the pedagogy of multiliteracies. In B. Cope & M. Kalantzis (Eds), *A pedagogy of multiliteracies: Learning by design*. London: Palgrave, 1–36.

Cox, J. 2016. *Benefits of technology in the classroom.* Downloaded 9 September 2017. http://www.teachhub.com/benefits-technology-classroom

Crawford, K. 2003. The role and purpose of textbooks. *International Journal of Historical Learning, Teaching and Research,* 3(2): 5–10.

Creswell, J.W. 2013. *Qualitative inquiry and research design.* Thousand Oaks, CA: Sage.

Davis, J.D. 2009, Understanding the influence of two Mathematics textbooks on prospective secondary teachers' knowledge. *Journal of Mathematics Teacher Education,* 12: 365–389.

Deetz, S.A. 1996. *Differences in approaches to organizational science: Rethinking Burrell and Morgan and their legacy*. Viewed 3 August 2017. http://links.jstor.org/sici?sici=1047-7039(199603%2F04)7%3A2%3C191%3ADDIATO%3E2.0.CO%3B2-U. 7 (2) pp. 191-207.

Denzin, N. 1983. Interpretive interactionalism. In G. Morgan (Ed.) *Beyond method.* Beverley Hills, CA: Sage, 129–146

Denzin, N.K. & Lincoln, Y.S. 2000. *Handbook of qualitative research,* 2nd ed. Thousand Oaks, CA: Sage Publications.

Devetak, I. & Vogrine, J. 2013. The criteria for evaluating the quality of the science textbooks. M.S. Khine (Ed.) *Critical analysis of science textbooks: evaluating instructional effectiveness.* Slovenia: Springer.

De Vos, A.S., Strydom, H., Fouché, C.B. & Delport, C.S.L. 2008. *Research at grass roots,* 4th ed. Pretoria: Van Schaik.

Dicker, G. 2011. *Berkeley's idealism: A critical examination*. Oxford: Oxford University Press.

Dey, I. 1995. Reducing Fragmentation in Qualitative Research. In Kelle, U. (Ed.) *Computer-Aided Qualitative Data Analysis: Theory, Methods and Practice.* London: Sage

Dowling, P. 1996. A sociological analysis of school mathematics texts. *Educational Studies in Mathematics,* 31: 389–415.

Dubai Airports. 2014. *Dubai Airports: Connecting the world*. Viewed on 2 March 2017. https://services.dubaiairports.ae/dubaimet/met/climate.aspx

Education History in Abu Dhabi. n.d. Abu Dhabi Education Council. Viewed 22 April 2017. https://www.adec.ac.ae/en/Education/Pages/Education-History-in-Abu-Dhabi.aspx

Eisenhardt, K. M. 1989. Building theories from case study research. *Academy of Management Review,* 14(4): 352–550.

Engelbrecht, A. & Hugo, A. Introduction. In print. In A. Engelbrecht (Ed.) *Multiliteracies in education.* Pretoria: Van Schaik.

Environment. 2017. *www.dictionary.com/browse/environment.* Viewed 10 February 2017.

Even, R. & Schwarz, B.B. 2002. Implications of competing interpretations of practice to research and theory in mathematics education. In A.D. Cockburn & E. Nardi (Eds), *Proc. 26th Conf. of the Int. Group for the Psychology of Mathematics Education (Vol. 2).* Norwich: PME, 337–344.

Foster, J. 1982. *The case for idealism.* London: Routledge & Kegan Paul.

Gage, N.L. 1989. The paradigm wars and their aftermath: a historical sketch of research on teaching since 1989. *Educational Researcher,* 18(7): 4–10.

GEMS Education. Accreditation and affiliation. c.2010. Viewed 12 January 2017. http://www.gemseducation.com/academic-success/accreditation-affiliation/Ahmed, K. 2010. English in the Arab Gulf. *Asian Journal of University Education,* 6(1): 1–12.

Genis, G. In Print. Multiliteracies as a postgraduate module. In A. Engelbrecht (Ed.) *Multiliteracies in education.* Pretoria: Van Schaik.

Ghamri, H. 2012. The impact of language and math proficiency tests on student academic achievement in HCT. Dissertation submitted in partial fulfilment of Master of Education program. The British University in Dubai: Faculty of Education, Dubai.

Giroux, H. 1988. Critical theory and the politics of culture and voice: Rethinking the discourse of educational research. In R. Sherman & R. Webb (Eds) *Qualitative research in education: Focus and methods*. New York: Falmer, 190–210.

Griffiths, R. & Clyne, M. 1994. *Language in the mathematics classroom.* Portsmouth, NH: Heinemann.

Guba, E.G. & Lincoln, Y.S. 1994. Competing paradigms in qualitative research. In N.K.

Denzin & Y.S. Lincoln (Eds) *Handbook of qualitative research*. Thousand Oaks, CA: Sage, 105–117.

Haggarty, L. 2001. An investigation of mathematics textbooks and their use in English, French and German classrooms: who gets an opportunity to learn what? In J. Winter (Ed.) *Proceedings of British Society for Research into Learning Mathematics*, 21(2) July. Available at bsrlm.org.uk

Hammersley, M. 2008. *Questioning qualitative inquiry*. London: Sage.

Hawthorne, J. 2005. The case for closure. In P. Sosa & M. Steup (Eds), *Contemporary debates in epistemology.* Chichester, UK: Wiley, 26–43.

Haylock, D. 1991. *Teaching mathematics to low attainers, 8–12.* London: Paul Chapman.

Henning, C.A. 1996. *Overcoming the limitations of mathematics textbooks in the middle school classroom.* US Department of Education: Educational Resources Information Center (ERIC).

Hesse-Biber, S.N. & Leavy, P. 2011. Introducing qualitative research. In K. Maree (Ed.) *First steps in research*, 2nd ed. Pretoria: Van Schaik, 50–70.

Hodgen, J. & Marks, R. 2013. *The employment equation: Why our young people need more math for today's jobs.* London. http://www.suttontrust.com/our-work/research/item/the-employment-equation-why-our-young-people-need-more-maths/

Horkheimer, M. 1993. *Between philosophy and social science*. Cambridge, MA: MIT Press.

Howson, G. 1995. *Mathematics textbooks: A comparative study of Grade 8 texts (Vol. 3).* Vancouver: Pacific Educational Press.

Huckin, T. 2004. Content Analysis: What Texts Talk About. In *What writing does and how it does it : an introduction to analyzing texts and textual practices*. Charles Bazerman (Ed.) Mahwah N.J.: Lawrence Erlbaum Associates, 2004:13-32.

Jewitt, C. (Ed). 2014. *The Routledge handbook of multimodal analysis.* New York: Routledge.

Johansson, M. 2006. Teaching mathematics with textbooks: A classroom and curricular perspective. Doctoral thesis. Lulea University of Technology: Department of Mathematics, Lulea.

Jones, G. 2006. *A dreaming, a sauntering: Re-imagining critical paradigms.* Downloaded on 2 April 2018. https://openjournals.library.sydney.edu.au/index.php/JASAL/article/viewFile/10181/10079

Khalaf, H. 2009. *Maths and science to be taught in English*. June 30. http://www.thenational.ae/news/uae-news/education/maths-and-science-to-be-taught-in-english

Khutorskoi, A.V. 2006. The place of the textbook in the didactic system. *Russian Education and Society*, 48(3), 78–93.

Kincheloe, J.L. & McLaren, P.L. 1994. Rethinking critical theory and qualitative research. In N.K, Denzin & Y.S. Lincoln (Eds) *Handbook of qualitative research.* Thousand Oaks, CA: Sage, 138–157.

Kline, M. 1974. *Why Johnny can't add: The failure of the new math.* New York: St. Martin's Press.

Langton, J. 2017. *UAE President announces plans to unify education in all government schools.* 3 September. https://www.thenational.ae/uae/uae-president-announces-plans-to-unify-education-in-all-government-schools-1.625336

Lederman, L. 2008. Science education and the future of humankind. *Science News* 173(16):1.

Lincoln, Y.S. & Guba, E.G. 1985. *Naturalistic inquiry*. Newbury Park, CA: Sage.

List of currencies of the World. Copyright 2008-2017. Countries of the World. Viewed 19 February 2017. https://www.countries-ofthe-world.com/world-currencies.html

Love, E. & Pimm, D. 1996. *This is so: a text on texts.* In A.J. Bishop, K. Clements, C. Keitel, J. Kilpatrick & C. Laborde (Eds) *International handbook of Mathematics education. Vol. 1*. Dordrecht: Kluwer, 371–409.

Maree, K. (Ed.). 2016. *First steps in research,* 2nd ed. Pretoria: Van Schaik.

Masudi, F. 2017. *Back to school: winds of change in UAE.* 27 August. http://gulfnews.com/news/uae/education/back-to-school-winds-of-change-in-uae-1.2080266

Maxwell, J.A. 2009. Designing a qualitative study. In L. Bickham & D.J. Rog (Eds) *The SAGE handbook of applied social research methods,* 2nd ed. London: Sage, 214–253.

McMillan, J.H. & Schumacher, S. 2001. *Research in education: A conceptual introduction,* 5th ed. New York: Addison-Wesley Longman.

Miles, M.B. & Huberman, A.M. 1994. *Qualitative Data Analysis* (2nd edition). Thousand Oaks, CA: Sage Publications.

Mohammad, R.F. & Kumari, R. 2007. Effective use of textbooks: A neglected aspect of education in Pakistan. *Journal of Education for International Development,* 3(1): 1–10. Aga Khan University, Pakistan.

Morton, A. 2002. *A guide through the theory of knowledge,* 3rd ed. Oxford: Blackwell.

New London Group (NLG). 1996. A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review,* Spring, 66(1): 60–92.

New School Model. c. 2009. Abu Dhabi Education Council. Viewed 20 April 2017. https://www.adec.ac.ae/en/Education/P12Education/Pages/New-School-Model.aspx

Nicholls, J. 2003. Methods in school textbook research. *International Journal of Historical Learning, Teaching and Research,* 3(2). http://www.ex.ac.uk/education/historyresource/journalstart.htm

Nieuwenhuis, J. 2016. Introducing qualitative research. In K. Maree (Ed.) *First steps in research,* 2nd ed. Pretoria: Van Schaik, 50–70.

Norris, E. 2012. *Solving the math problem: International perspectives on mathematic education.* https://www.thersa.org

Oates, T. 2014. *Why textbooks count.* Policy paper. November. University of Cambridge, Local Examinations Syndicate.

O'Byrne, W.I. & Smith, S.A. 2015. Multicultural education and multiliteracies: Exploration and exposure of literacy practices with preservice teachers. *Reading & Writing Quarterly,* 31(2): 168–184.

Ogan-Bekiroglu, F. 2007. To what degree do the currently used Physics textbooks meet the expectations? *Journal of Science Teacher Education,* 18: 599–628.

Pahl, K. & Roswell, J. 2013. *Literacy in education: Understanding the New Literacy Studies in the classroom,* 2nd ed. London: Sage.

Parrish, B. 2004. *Teaching adult EAL: A practical introduction.* New York: McGraw Hill.

Patton, M.Q. 1990. *Qualitative evaluation and research methods.* Newbury Park, CA: Sage.

Patton, M.Q. 2002. *Qualitative evaluation and research methods,* 3rd ed. Thousand Oaks, CA: Sage.

Polkinghorne, D.E. 1989. Introducing qualitative research. In K. Maree (Ed.) *First steps in research,* 2nd ed. Pretoria: Van Schaik, 50–70.

Punch, K. 1998. *Introduction to social research: Quantitative and qualitative approaches.* London: Sage.

Rain and rainfall in the UK. 2017. MET Office. Viewed 30 April 2017. http://www.metoffice.gov.uk/learning/rain

Reisigl, M. & Wodak, R. 2001. *Discourse and discrimination*. London*:* Routledge.

Reports and statistics. n.d. Updated 30 July 2017. United Arab Emirates, Ministry of Education. Viewed 18 April 2017. https://www.moe.gov.ae/En/OpenData/Pages/ReportsAndStatistics.aspx

Rezat, S. 2009. *The utilization of mathematics textbooks as instruments for learning.* Justus-Liebig-University Giessen, Germany. Proceedings of CERME 6, Lyon France, INRP 2010. www.inrp.fr/editions/cerme6

Ritchie, J. & Lewis, J. (Eds). 2003. *Qualitative research practice: A guide for social science students and researchers.* London: Sage.

Rogers, R. (Ed.). 2003. *An introduction to critical discourse analysis in education.* Mahwah, NJ: Lawrence Erlbaum.

Rosenthal, M. 2016. Qualitative research methods: Why, when, and how to conduct interviews and focus groups in pharmacy research. *Currents in Pharmacy Teaching and Learning*, 8(4): 509-516.

Roswell, J., Kosnik, C. & Beck, C. 2008. Fostering multiliteracies pedagogy through preservice teacher education. Teaching Education, June, 19(2): 109–122.

Sandelowski, M. 2010. What's in a name? Qualitative research revisited. *Research in Nursing and Health,* 33: 77–84.

Schools in the UAE. n.d. UAE Education Network. Viewed 19 April 2017. http://www.edarabia.com/schools/uae/

Scotland, J. 2012. *Exploring the philosophical underpinnings of research: Relating ontology and epistemology to the methodology and methods of the scientific, interpretive, and critical research paradigms.* 25 July. http://www.ccsenet.org/journal/index.php/elt/article/view/19183/12667

Seale, C., Gobo, G., Gubrium, J.F. & Silverman, D. (Eds). 2007. *Qualitative research practice*. London: Sage.

Seidel, J. V. 1998. Qualitative data analysis. Originally published as Qualitative Data Analysis, in The Ethnograph v5.0: A Users Guide, Appendix E, 1998, Colorado Springs, Colorado: Qualis Research. Retrieved 4/4/2017, from http://www.qualisresearch.com/qda_paper.htm

Selber, S. 2009. *Multiliteracies for a digital age*. USA: Southeastern Illinois University Press.

Sharjah ruler supports establishment of "Arabic Tongue Council" in Nouakchott. 2017. 29 June. UAE Interact. Viewed on 2 March 2018. http://www.uaeinteract.com/docs/Sharjah-Ruler-supports-establishment-of-Arabic-Tongue-Council-in-Nouakchott/79634.htm

Shellard, E. & Moyer, P.S. 2002. *What principles need to know about teaching math.* Alexandria, VA: National Association of Elementary School Principals and Education Research Service.

Silverman, D. 2013. *Doing qualitative research.* Thousand Oaks, CA: Sage.

Snyder, J. 2014. *Foreign textbooks should be put into context for the UAE.* 22 March. http://www.thenational.ae/thenationalconversation/

Social Statistics: Education. 2017. Statistics Centre of Abu Dhabi. Updated 27 July 2017. Viewed 16 August 2017. https://www.scad.ae/en/pages/statistics.aspx?topicid=23

Stake, R.E. 1995. *The art of case-study research.* Thousand Oaks, CA: Sage.

Sujee, E. In Print. Technological literacy. In A. Engelbrecht (Ed.) *Multiliteracies in education.* Pretoria: Van Schaik.

Swanepoel, S. 2010. The assessment of the quality of science textbooks: conceptual framework and instruments for analysis. Doctoral thesis. University of South Africa.

Tabari, R. 2014. *Education reform in the UAE: an investigation of teacher's views of change and factors impeding reforms in Ras Al Khaimah schools.* Working paper 07. UAE: Sheikh Saud Bin Saqr Al Qasimi Foundation for Policy Research.

Terre Blanche, M., Durrheim, K. & Painter, D. (Eds). 2006. *Research in practice.* Cape Town: Juta.

Theory, sources and evidence in reflective writing for assignments. Viewed 15 August 2017. http://www.bradford.ac.uk/academicskills/media/learnerdevelopmentunit/documents/workshopresources/confidenceinreflection/Thy,-scs-and-evi-in-Ref-W-Ass-Booklet---Student.pdf

Tyson, H. 1997. *Overcoming structural barriers to good textbooks*. Inverness, CA: Inverness Research Associates.

UNESCO Education in the UAE. c.2009. United Nations. Viewed 20 February 2017. http://en.unesco.org/education

United Nations Development Programme, regional bureau for Arab States, Programme on Governance in the Arab Region (POGAR) Education Index 2005. www.pogar.org/countries/indicator.asp

Valverde, G.A., Bianchi, L.J., Wolfe, R.G., Schmidt, W.H. & Houang, R.T. 2002. *Using TIMSS to investigate the translation of policy into practice through the world of textbooks.* Dordrecht: Kluwer.

Van Dijk, T. 1993. *Elite discourse and racism*. Newbury Park, CA: Sage.

Wellington, J. & Osborne, J. 2001. *Language and literacy in Science education.* Buckingham: Open University Press.

Wen-Cheng, W. 2010. Thinking of the textbook in the EAL/EFL classroom. *English Language Teaching*, 4(2): 91–96). Canadian Centre of Science and Education.

Wilson, T. 1997, Electronic publishing and the future of the book, *Information Research*, 3(2). Available from: http://informationr.net/ir/3-2/ paper39.html [last accessed on 2008-11-12].

Wodak, R. 1996. *Disorders of discourse*. London: Longman.

Wodak, R. 2001. What CDA is about. In R. Wodak & M. Meyer (Eds) *Methods of critical discourse analysis.* London: Sage, 5.

Wolcott, H. F. 1994. *Transforming qualitative data: Description, analysis, and interpretation*. Thousand Oaks, CA: Sage.

Yin, R.K. 2009. *Case study research: Design and methods,* 4th ed. Thousand Oaks, CA: Sage.

Zaman, S. *UAE adopts new Emirati School Model.* Published 3 September 2017. http://gulfnews.com/news/uae/government/uae-adopts-new-emirati-school-model-1.2084511