EXPLORING THE EMBODIMENT OF A SECONDARY MATHEMATICS TEACHER

by

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DISSERTATION

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DECLARATION

I declare that the dissertation, **Exploring an embodiment of a secondary mathematics teacher**, hereby submitted to the University of Limpopo, for the degree of **Masters in Mathematics Education** has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

Rawane MG (Mrs) 12/ 12/ 2016

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ABSTRACT

Sarton (1936) stated that mathematics has grown so large for a single mind to grasp. Mack (1961) attributes that phenomenon by claiming that mathematics differs from science in that it keeps on adding new concepts to existing ones, whereas in science there is reduction of concepts. This continuing growth makes it impossible for an individual to study mathematics as a whole (Krantz, 2010). Van Bendegem (2009, p. 137) calls the mathematics world a “mad world”. Recently, Ellerton (2014) compared mathematics to a growing tree. A number of challenges arise out of the observations made above. Is the mathematics that is taught in secondary schools an appropriate reflection of the mathematics that is out there today? Is an individual an appropriate embodiment of a secondary mathematics teacher? In the mist of these and many other questions, this study locates itself in the second question and investigated the notion of an embodiment of a secondary mathematics teacher. The main research question that was pursued was ‘How adequate is an individual as an embodiment of a secondary mathematics teacher?’ This question should be understood and interrogated in the context of Festinger’s (1962) dissonance cognitive theory that also serves as the theoretical framework for the study. The expectations of a secondary mathematics teacher do not fit in with an individual’s capacity to embody those.

Grounded theory (Glaser, Strauss & Beer, 1967) was used to generate and develop what Elliot and Higgins (2012) called a substantive theory. This was a desktop grounded theory study and data was collected from existing literature of published journals and books. Since the use of documents is recommended as one of the qualitative data collection methods in grounded theory (Strauss & Corbin, 1990), the documents served as primary data where only a few that were relevant to the issues discussed were selected (Breckenridge & Jones, 2009). Content and thematic analyses procedures were used. Content analysis assisted to organise data according to various eras, tracing the growth in mathematics education and mathematics content, comparing them to a mathematics teacher of different eras, which assisted in bringing the answer to the research question posed (Bowen, 2009). Thematic analysis was used to identify commonalities and differences with regard to the notion of a teacher in various eras (Fereday & Muir-Cochrane, 2006).

The findings revealed that the notion of a secondary mathematics teacher of the current era is completely not a suitable embodiment of a secondary mathematics teacher. The current notion of an embodiment of a secondary mathematics teacher is seriously challenged by this ever growing subject. Secondary mathematics is so large for an individual to acclimatise with (Sarton, 1936), and there seems to be a need for more than an individual to ensure that mathematics is well taught and learned by learners. It is recommended that other studies should be undertaken to determine as to how many individuals can constitute a composite suitable to embody the requirements of an ideal secondary mathematics teacher.

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CHAPTER 1: BACKGROUND OF THE STUDY

1.1. Introduction

South Africa has long been faced with issues regarding poor performance in secondary mathematics (Cohen & Seria, 2010), where the teachers even failed to answer the questions from their grade six learners' syllabus (Carnoy, Ngware & Oketch, 2015). Of course there are a number of issues contributing towards this underperformance. Most of the issues have been identified by several studies and interventions were done towards solving the problem. Irrespective of all the efforts to remedy the situation, learners have been continuing to underperform in secondary mathematics, showing that the main problem causing underperformance has not yet been identified (Karigi & Wario, 2015).

On the other hand, mathematics has been observed to be growing so large for an individual to acclimatise with (Sarton, 1936). Mathematics content (for a particular grade) has expanded from being packaged in a 16 pages textbook (Clements & Ellerton, 2010), to more than 300 pages textbook in the current era. Furthermore, Krantz (2010) confirmed that today's mathematics is large and complex; one can only study a piece of it. Ellerton (2014) compared mathematics growth to a growing tree. This continuous growth has always triggered changes made with regard to the school mathematics. For example, at some stage learners studied arithmetic, then sums and divisions in slates, followed by lined paper tablets, and currently logging onto the internet (Pejouhy, 1990). Also, the curriculum keeps on changing with the aim to better the education of the learners.

Considering the growth in the subject, do we still expect the same notion of a secondary mathematics teacher like the one who used to teach manageable mathematics content packaged in a 16 pages book (Clements & Ellerton, 2010) to still apply in today's world with such an enormous content? A list of studies (Lim, 2007; Global Campaign for Education, 2012; Hill, Blazar & Lynch, 2014) recommended that an effective teaching was mostly observed when teachers worked as a group. This challenges the notion of an individual as an appropriate embodiment of a secondary mathematics teacher. An individual does not have the capacity to embody the complexities of the content of mathematics and its associated pedagogical demands. Various issues regarding a secondary mathematics teacher have been looked into, including the history of the subject and its growing demands.

It must be acknowledged that a lot has and still continues to be done to resolve the apparent challenges in the teaching and learning of mathematics. Teachers continue to be trained, new textbooks are written, curricula are reviewed, new teaching media are introduced but the problem with mathematics learning continues to bedevil us. If so much is being done, then why are learners still not being able to achieve better results in mathematics? Is this not alerting us that we have not yet found the real problem that causes underperformance (Karigi & Wario, 2015) in secondary mathematics? It is in this context that this study sought out to investigate the notion of a secondary mathematics teacher, especially the embodiment of such a notion.

1.2. Research problem

The knowledge that characterises teaching continues to grow every day and the same applies to the mathematics knowledge. To date the only visible attempt to deal with the complexities has been in the vertical differentiation of teacher qualifications, especially with regard to initial teacher qualifications. The Revised Policy on the Minimum Requirements for Teacher Qualification (Department of Higher Education and Training, 2015), for example, shows qualifications at Foundation Phase, Intermediate Phase, Senior and Further Education and Training Phase. Both content and pedagogical aspects of the respective training programmes are different as they deal with a learner at a different passage of their development. The deficiency in the policy is in the absence of the horizontal differentiation. The impression created is that all that is required in a particular phase can be embodied in an individual teacher. It is argued in this dissertation that mathematics has grown to an extent where it has become extremely large for an individual to acclimatise with (Sarton, 1936). It is in this context that I posit that the characteristics of an individual secondary mathematics teacher are not enough to epitomise a true and appropriate secondary mathematics teacher that the current 21st society needs. The embodiment of a teacher as an individual is seemingly inadequate.

Almost all current research on mathematics teachers never placed the ideal teacher in one person because most of them keep on emphasising the need for teachers to work together as a team in order to produce better understanding of mathematical concepts in learners (Askew, Rhodes, Brown, William & Johnson, 1997; Lim, 2007, Hunt, 2009; Hill et al., 2014). Though it is not directly declared what constitutes characteristics of an ideal mathematics teacher, it has always been a derivation of features from a group. In this crisis of representation of an embodiment of a mathematics teacher, it is perhaps time to face reality and ask what or who could better embody a secondary mathematics teacher? Bearing in mind that this problem cannot necessarily be resolved instantly, the idea is to initiate a discussion that will hopefully lead to a solution in the future.

1.3. Significance of the study

The notion of a teacher has a direct bearing on teacher education policies, employment of teachers, training of teachers, and ultimately the way learners learn. If the notion of a teacher is that of a composite, then the way individuals come into the composite is significant. Their training must recognise their individual needs and roles in the composite. Their continuing professional programmes must acknowledge both individual and composite needs. Teacher education literature, research and professional formations should find ways in which they can support that kind of notion or concept of a teacher.

In the short term, the significance of this study is in its role in placing on the agenda, the reflections on the adequacy of the current notion of a secondary mathematics teacher. This will be observed in the conference papers, articles and other publications in which the issue is being raised. It is only when critical masses of discussions are in place that one will expect a policy response on teacher education.

1.4. Purpose of the study

The purpose of this study was to investigate the embodiment of a secondary mathematics teacher in the context of the continuing growth in mathematics content and mathematics education. That is, if we go back 1000, 100, or 50 years and ask, what is a secondary mathematics teacher, can we come to the same conclusion? If an individual had sufficient capacity in the past to embody the notion of a secondary mathematics teacher, then, can we still confidently assume that in today's world such an embodiment is still viable? We are currently witnessing a number of studies that have identified a lack of sufficient content knowledge (Ali, 2011; Vistro-Yu, 2003), lack of confidence in teachers (Moodley, 2014), too much workload on teachers (Karigi & Wario, 2015) etc., as some of the reasons for underperformance in mathematics. But the question remains, is an individual having sufficient capacity to embody what is required of an ideal secondary mathematics teacher? Put it differently, can we package all the necessary intervention programmes around an individual?

Various interventions such as introducing technology in the mathematics classroom (Malden, 2006; Moursund & Albrecht, 2011; Pia, 2015; Swee, 2015; Teo & Milutinovic, 2015) and encouraging teachers to enrol in the professional development programmes (Deshler, Hauk & Speer, 2015; Dreher, Kuntze & Lerman, 2015) were done, but still they did not lead to noticeable and sustained change to poor performance in mathematics. It was in response to such observation that Karigi and Wario (2015) argued that we have not yet found the real problem towards underperformance in mathematics. This study brings into the sharp focus, the need to ask the question of capacity of an individual as an embodiment of an ideal mathematics teacher.

1.5. Research question

How adequate is an individual as an embodiment of a secondary mathematics teacher?

Through this question I was reflecting on the capacity of an individual to be trained in all aspects of an ideal secondary mathematics teacher. That is, can what is known to date as the desirable qualities of a secondary mathematics teacher be packaged into a training programmes, and be mastered by an individual? In order to address this challenging issue, a set of three sub-questions were asked:

How has the notion of a secondary mathematics teacher changed over a period of time?

How is the continuing growth in mathematics affecting the embodiment of a teacher?

What are the qualities of a new conception of a secondary mathematics teacher?

The idea was not to provide fixed or accurate answers to these questions. Instead they assisted me in packaging my argument as I attempt to place the issue on the agenda for mathematics education.

1.6. The structure of the report

This report consists of five chapters. Chapter 1 outlines the background of the study regarding the embodiment of the notion of a secondary mathematics teacher. The research problem, significance and purpose of the study, together with the research question have also been outlined in this chapter. In chapter 2, the literature has been reviewed starting with the theoretical framework, whereby cognitive dissonance theory of Festinger (1962) has been adopted in line with grounded theory. Furthermore, the literature has been divided into sub-topics which were somehow related to the issues around the embodiment of a teacher. Chapter 3 entails the research methodology, whereby the research design, methods of sampling and how data was collected and analysed were discussed. Data was collected from published books and journals. Again, the issues of credibility, authenticity, transferability, bias and ethical considerations were taken into consideration in chapter 3. The results have been presented in chapter 4, and they have been divided into different eras looking at the embodiment of a secondary mathematics teacher in each era, and further reflected on the findings of a teacher in each era. Chapter 5 outlines the recommendations, limitations of the study and the concluding remarks and since the problem that was investigated in this study cannot be resolved instantly, the conclusion only makes all the stakeholders to be aware and acknowledge the crisis we are in with regard to the embodiment of a secondary mathematics teacher. The recommendations also come up with suggestions of a suitable embodiment of today‘s secondary mathematics.

1.7. Conclusion

This chapter provided the introduction and background to the study which emphasised issues related to the study. It further highlighted the research problem which dealt with the notion of today’s secondary mathematics teacher. The current notion of a secondary mathematics teacher seems to no longer be adequate to offer the necessary skills and knowledge to learners such that they are able to see mathematics as something to be applied on their daily living (Kitta, 2015; Azuka & Kurume, 2015). Irrespective of all the challenges stated by many studies regarding the underperformance in secondary mathematics, it seems the problem towards underperformance in mathematics has not yet been identified (Karigi & Wario, 2015).

The significance and the purpose of the study were also outlined, where the main focus was to investigate the notion of a secondary mathematics teacher who could be a suitable embodiment of a teacher in the current era, and be able to deal with today’s large and complex mathematics (Krantz, 2010). This could then assist with the underperformance in mathematics that our country is currently faced with. It was acknowledged that this study cannot solve the problem as it could only be resolved over time, but worth bringing to attention that the current notion of a secondary mathematics teacher needs to be reviewed. There was only one research question asked in the study which consisted of three sub-questions, which was supported by Elliot and Higgins (2012) that a research question should be posed in grounded theory. Finally the structure of the report as a whole was outlined to guide readers.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The first part of this section locates the study to its theoretical framework. Also the definition of the word “embodiment” has been outlined in the context of this study. It has also been discussed on who a secondary mathematics teacher is referred to. Literature focusses on the origin of teaching in the eras Before Christ (BC) where there were no schools, to Anno Domino (AD) eras where primary and secondary schools were established. It further considers the training of primary teachers against eras where secondary teachers were initially not trained, and later trained, and further the different ways in which primary and secondary teacher training differ. The growth in mathematics as a subject plays an important role as it has major impacts on the notion of an embodiment of a teacher. Again, there have been discussions of what mathematics is and its importance. Furthermore, the challenges faced with regard to mathematics have been looked into, and also the qualities expected today from a secondary mathematics teacher such that he can operate effectively so. Lastly the emphasis that an individual teacher seems inadequate to be a suitable embodiment of a secondary mathematics teacher to teach mathematics effectively has been put as a concluding issue, considering all factors discussed regarding mathematics as a subject.

2.2. Theoretical framework

In this dissertation, the theories adopted were both substantive theory and classic grounded theory (Elliot and Higgins, 2012). Both theories allow a research question to be formulated before data collection (Elliot & Higgins, 2012; Bitsch, 2005) and in this thesis, similar theories were adopted as there was first a research question posed about a suitable notion required to embody a secondary mathematics teacher of the current era, who would qualify to teach this ever growing mathematics. The difference of this thesis to that of Higgins was that he engaged participants through interviews (Elliot & Higgins, 2012) whereas this was a documentary analysis kind of thesis.

On the other hand, Glaser (1998) discussed the issue of finding a pattern in developing a theory, whereas Elliot and Higgins (2012) noted that as the study unfolded there should be categories developed to ensure that the question posed assists in identifying relevant issues to the study. Hence in this thesis, content analysis was used to organise and develop data into categories such that they could address the question posed (Bowen, 2009; Elliot & Higgins, 2012), and further arranged data into various eras. Thematic analysis was also used to assist in identifying the pattern that was revealed from the data (Fereday & Muir-Cochrane, 2006), whereby there was a comparison on the notion of the teacher in various eras, and how mathematics contents and mathematics education have been growing, and how this growth has affected a teacher, to allow theory to emerge (Gillian, Palmer & Bolderson, 2013). Using both content and thematic analysis allowed other related issues to the posed question to be addressed. These issues were then made to serve as sub-questions. The analytic memos are said to assist in capturing and tracking conceptual ideas, and allows the researcher to document his/her own ideas that are non-grounded about the emerging theory (Glaser, 1998), which was also the case in this thesis.

Classic grounded theory approach allows the theory to emerge from the use of literature (Elliot & Higgins, 2012). Morse (2001, p. 9) noted that “literature should not be ignored but rather ‘bracketed’ and used for comparison with emerging categories”. On the contrary, Bitsch (2005, p. 77) stated that “a grounded theory project typically does not begin with a theory from which hypotheses are deducted, but with a field of study or a research question”. I am against Bitsch’s (2005) approach as I do believe that indeed one cannot erase the theory that she or he already has in mind before starting the research (Glaser et al., 1967), and therefore considered Morse (2001) by not ignoring the literature because the literature would cultivate ideas “within the framework of the developing theory by constantly comparing one’s own and others’ theoretical ideas with the emerging data” (Elliot & Higgins, 2012, p. 9). This preliminary reviewing of the literature is called “Foucault theory of power” (Elliot & Higgins, 2012, p. 5). Hence it has been highlighted in the research design section about the generation and refining of categories with the intention to compare the researcher’s ideas with those of other authors. So the experiences of the researcher with regard to the notion of a secondary mathematics teacher theory were compared to what the literature hold (Glaser, 1992) to avoid imposing and concluding without allowing theory to emerge (Elliot & Higgins, 2012).

Similarly, as from the Higgins' study, there was no way that the researcher would have known the responses of the participants beforehand (Elliot & Higgins, 2012), so also in this thesis what literature held was not known beforehand, hence even the literature used in this study was sampled theoretically due to its relevancy (Strauss & Corbin, 1990; Breckenridge & Jones, 2009). So the "literature is discovered as the theory is" (Glaser, 1998, p. 69). In this way it is believed that the researcher would "generate a theory that transcends the literature, synthesise it at the same time" (Glaser, 1998, p. 120) and further allows a theory that was relevant to the study to emerge (Elliot & Higgins, 2012).

Baxter and Eyles (1997) mentioned peer debriefing as one of the strategies in classic grounded theory approach, where they asked a probing question to find a different opinion. This peer debriefing was also catered for in this thesis as it was mentioned in transferability that there was an independent scholar consulted, who would constantly assist in interpreting the literature to avoid the researcher doing interpretations that would jeopardise the results. Furthermore, Elliot and Higgins (2012) mentioned the need for self-correcting process to avoid the imposing of assumptions and pet ideas. In this thesis, reading of the literature repeatedly assisted in doing self-correcting process. Also the "categories, properties and their relationships were checked repeatedly using the constant comparative process and theoretical sampling" to observe the pattern in emerging and previous data (Elliot & Higgins, 2012, p. 3), which was also catered for in this thesis.

Grounded theory was said to be inductive (Bitsch, 2005), but Elliot and Higgins (2012) believed it was both inductive and deductive, since classic theory can be inductive methodology in the beginning as it builds theory, and to make it wholly inductive, one should ignore its deductive components during theoretical sampling by focusing where more data could be found. Unlike Bitsch (2005), this thesis was in line with Elliot and Higgins (2012), whereby initially the classic theory was inductive, and the data which was irrelevant to the study was deduced by means of theoretical sampling (Strauss & Corbin, 1990; Breckenridge & Jones, 2009) to make it wholly inductive (Elliot & Higgins, 2012).

Finally, as highlighted from Elliot and Higgins (2012) after all the stages of explaining the theoretical framework in the study have been completed, the researcher should position themselves from one of the three theories mentioned as theory of self-presentation (Goffman, 1959), cognitive dissonance (Festinger, 1962) and interpersonal theory (Peplau, 1952). Theory of self-presentation has been said to be defining the nature of a social situation (Goffman, 1959). Interpersonal theory on the other hand deals with the purpose of nursing for others by identifying their difficulties with the principle of human relations. Festinger (1962) explained cognitive dissonance as a theory whereby there has been an idea on something, with a little bit of knowledge on that idea relating to a variety of thoughts or facts. Since this study began with a researcher having experience and knowledge on the issues related to the notion of a secondary mathematics teacher, this thesis then fitted well with the cognitive dissonance of Festinger (1962).

2.3. Definition of an embodiment

The word embodiment comes from embody. To embody something means to assemble into or to accommodate in a body (Dictionary.com, n.d.). As from Bacchini's (2014, p. 27) publication of Cambridge English Dictionary, to embody is to "represent a quality or an idea". Merriam Webster (2011)'s dictionary explained embodiment as someone who can serve as a good representation of a quality.

From all the meanings that were mentioned above, and also from the context in which the word "embodiment" was used in this study, I would explain embodiment of a secondary mathematics teacher as someone that will be suitable candidate to serve as a good representation to offer mathematics in a way that is required today.

2.4. Who is the secondary mathematics teacher?

A secondary mathematics teacher is referred to as someone who has been to a higher institution of learning and studies a certain diploma or degree in teaching and such a person specialises in mathematics. The responsibilities of such a teacher will be to teach all the contents that are there in secondary mathematics, prepare lessons before s/he can teach, provide instructions to learners and examine learners. This implies the need for a secondary mathematics teacher to have an in-depth knowledge of the contents (The Education Alliance, 2006; Pejouhy, 1990; Anthony & Walshaw, 2007; Adams, 2012; Ekmeckci, Corkin & Papakonstantinou, 2015; Kaino, 2015) in secondary mathematics.

From the abstract of Paul (1989) it emphasises the importance of a secondary mathematics teacher to have "pedagogical and curriculum knowledge, knowledge of classroom organisation, and knowledge of the school context". So, this would have an impact on how the teachers are trained. Hence Monk (1994) mentioned that we must pay attention to "policy implications for teacher education, recruitment and retention. It is very much important to consider how secondary mathematics teachers are trained.

2.5. Origins of teaching

The originality of teaching comes a long way where children imitated what their parents did, like speaking, walking, eating etc. Then the teaching was further observed when people with knowledge and wisdom on something would gather people around and teach them (Davis, 1978). The herdsmen learned how to count their animals because of the basics of some counting, and were further able to distribute their inheritance by making use of knowledge on division (Allen, 2000). There were no formal buildings known as schools in BC eras and the eras of the 1st Century as verified by Davis (1978) because in 1607 people were taught in a family house in England, for example.

2.6. Establishment of schools

Holsinger and Cowell (2000) noted that in 1599 the Jesuits came up with specifications and contents of subjects. This then resulted in the formation of formal schooling, starting with primaries in 1624 in London (Davis, 1978) and secondary schools in the year 1813 in India (Sharma, 2013), 1821 in Europe (Holsinger & Cowell, 2000), and 1825 in the United States of America (Brown, 1899). Primary schools were established before secondary schools and primary school teachers were trained, but on the contrary, when secondary schools were established, secondary teachers were not trained in pedagogy (Davis, 1978).

2.7. Training of secondary school teachers

We observed an outcry from the studies by Conant (1892) for training of mathematics teachers in particular, supported by those of Hanus (1897) and Jacobs (1897) for training of secondary teachers in general. Jacobs (1897, p. 376) added that "conception that mere knowledge alone… makes a good teacher" was destroyed as there was a need for one to be trained to become either a primary or a secondary teacher. We even observed from Dexter (1906) coming up with plans on how mathematics curricular should be. On the other hand, the emergence of the National Council of Mathematics Teachers in 1920 (Austin, 1921) ensured that mathematics teachers received the necessary support required to teach the subject.

The belief was that if teachers were trained, and some even specialised in mathematics (Rao & Vijay, 2011), the performance might improve, which happened not to be the case (Karigi & Wario, 2015). A challenge might have been that there were no thorough investigations done on how this training was supposed to be. Rahman, Jumani, Ackter, Chisthi and Ajmal (2011, p. 151) maintained that training of teachers was supposed to provide knowledge and skills appropriate to professional life, and further to establish "clear performance goal" and the ability to "communicate them to learners", which seems to be tough to most teachers.

2.8. Growth in mathematics contents and its importance

It was believed that mathematics originated from around 3000BC (Paul, 1994), but Sarton (1936) claimed that mathematics existed even in the 5th centuries BC as it has been exercising human minds. Mathematics started having only a 16 pages textbook (Clements & Ellerton, 2010) and today it has more than 300 pages textbook at the secondary level, which emphasises the growth in the contents of the subject. The teacher who taught during the eras of a 16 page textbook has been trained the same way as the one who is now supposed to ensure that the contents covered in 300 or more pages textbook are delivered in a satisfactory way.

Mathematics seems to have been growing so large since its introduction. Sarton (1936, p. 7) mentioned that "the mathematical universe is already so large and diversified for a single mind to grasp". In addition, Mack (1961) further confirmed that mathematics keeps on adding concepts onto the existing ones unlike in sciences where new concepts seem to be subtracting the existing ones. As for Ellerton (2014) mathematics was said to be compared to a growing tree which is steady and strong in its roots, but getting larger and diverse due to a list of factors. This indeed proves that the growth of concepts in mathematics is becoming immeasurable than one can imagine. Even Duval (2000) mentioned that mathematics covers a broad and various range of contents from primary schools to university. Van Bendegem (2009, p. 137) added that "Math world is a mad world". It is indeed a confusing world. Ginsburg, Lee and Boyd (2008, p. 1) also identified the growth in the primary mathematics to be "wide ranging and sometimes abstract as it involves processes of thinking as well as skills and rote learning"

It has also been shown that this growth in mathematics may never stop even in the coming centuries (Devlin, 2008). Sutar and Uppal (2006, p. 1) noted that there are new branches in mathematics as a "response to new technological needs". On the other hand, Pejouhy (1990) confirmed that education was transformed and changes are brought. While this is the case, it is of importance that mathematics grows as there are reasons behind its growth. Pejouhy (1990, p. 2) also added to say "never before has so much been expected of us… and depended on us".

"The growth in mathematics occurs because there are demands for new ways to solve problems" (Devlin, 2008, p. 4). McLennan (2009) mentioned that new concepts are introduced due to relevancy and enlightening in the application to pre-existing mathematical experiences, and then becomes an object of study in itself. In the past even if a teacher would have taught a few things in mathematics, he would have succeeded (Pejouhy, 1990), unlike today where there is a lot to teach and learn in mathematics. So the question still remains to say as much as these new concepts are introduced, where some of them even qualify to be made subjects on their own, what about the notion of an embodiment of a teacher who teaches mathematics?

2.9. What mathematics is and its importance

“Mathematics is the bedrock of the economic and technological development of any nation” (Azuka & Kurume, 2015, p. 50), but its study is faced with many challenges at all stages. Cai et al. (2009) believe mathematics is a language and it is supposed to be made hands-on as it is derived from real life. So an educator who is unable to make mathematics practical is in no way going to be able to achieve the desirable outcomes in mathematics. Educators must at all times make mathematics hands-on, visual and practical (Anthony & Walshaw, 2007; Victoria University, 2008) so that learners can make sense of it and be aware that they are not just learning mathematics as a subject, but also as a device to make use of in their daily lives (Kitta, 2015; Azuka & Kurume, 2015).

In addition, mathematics should be presented as a “system of ideas, concepts and understandings, not simply as unrelated procedures, facts and algorithms” (Malden, 2009, p. 6), and for a teacher to be able to present mathematics as it should be, there is a need for teacher effectiveness. Portman and Richardson (2012, p. 4) defined mathematics as “a way of organising our experience of the world”, as it can “describe and explain, but it can also predict what might happen” in future. Subsequently, mathematics enhances our understanding and allows us to communicate and make sense of the world at large, and yet brings joy as it allows us to solve real life problems and can also be used in many areas of life (Portman & Richardson, 2012). Had it not been through the basics in mathematics, there would be no buildings because buildings require knowledge of angles, shapes, calculations etc. and further there would have been no ability to count money as also Civil (2008) cited that learners’ knowledge of money can enhance their learning of arithmetic with whole and decimal numbers.

Allen (2000, p. 1) said: “human needs that inspired mankind’s first efforts at mathematics, arithmetic in particular, were counting, calculations and measurements”. So mathematics was born to ensure that a lot of things become possible and easy to do. It offers guidance on how to do things (Sutar & Uppal, 2006). Indeed mathematics is important, and it makes life easier. One cannot imagine life without mathematics. Bakar, Tarmizi, Nor, Ali, Hamzah, Samad and

Jamian (2010, p. 393) supported the need for mathematics by saying that "mathematics and science are critical to the economy and progress of a nation".

2.10. Challenges faced in mathematics teaching

2.10.1. Lack of adequate content knowledge in teachers

Currently there are issues raised about mathematics teachers lacking adequate content knowledge (Burton, Daane & Giesen, 2008; Ali, 2011; Vistro-Yu, 2003) and lack of confidence (Moodley, 2014) in teaching mathematics. Ali (2011, p. 63) said "lacking prior knowledge of concepts is a chronic deficiency, which may not be addressed through easy ways or quick fixes". McGraner, Amanda and Lynn (2011, p. 4) added that "strong mathematical knowledge at a greater depth and span are not likely to foster students' ability to reason, conjecture and problem solve". Moreover, mathematics questions which educators use in their classrooms also seem to be frustrating learners as they are not related to the context which they find themselves in (Kakai, 2011). Deshler et al. (2015, p. 639) mentioned that "what instructors do in the classroom makes a difference in the learning opportunities students have". The lack of content knowledge in educators is a contributing factor towards educators' failure to come up with mathematical problems which are relevant to the environment within which their learners found themselves in. This makes the challenges of learners becoming uninterested in mathematics because they believe it is tough and fail to see how it fits in their daily living.

2.10.2. Primary teachers not having specialised in mathematics during training

Global Campaign for Education (2012) mentioned that the way in which teachers teach, the approaches they use, their way of managing time and their classroom management strategies should have a significant role to the learners. Besides that, Ali (2011) pointed out the issue of secondary learners not performing well in mathematics being due to lack of quality intervention at the primary level. It was found by Global Campaign for Education (2012, p. 30) that in Mali, teachers are not taught the "core competencies, skills or even the languages required by the current primary school curriculum" and in Lesotho lecturers failed to provide learning environment similar to what is expected in primary schools. On the other hand, Ginsburg et al. (2008) said early childhood educators' readiness to teach mathematics is doubtful, and this was supported by Bishop and Nickson (1983, p. 44) when they said "primary teachers are vulnerable as a result of their relative lack of mathematical expertise". So indeed the in-competencies found in primary teachers cannot be overlooked.

Bearing in mind that young children are said to develop a massive daily dose of mathematics, and are also proficient of learning more and extreme than usually expected (Ginsburg et al., 2008), therefore there should be a reason why they are failing mathematics. On the other hand, the training of primary teachers was in such a way that a teacher was supposed to teach all the subjects (Education and Culture, 2011), where there was no specialisation in a particular subject. This made it difficult for primary teachers to be able to focus on one subject and master it, whereas they are expected to lay foundation in mathematics, which seems difficult to these teachers and then lack of mathematical foundation becomes a challenge as learners reach secondary schools. Hence Ali (2011, p. 60) stated that "students were taught by primary teachers who themselves did not have a command over subject matter knowledge in mathematics". On the other hand, such teachers would make repetition in topics that are simple to them leading to failure in covering the curriculum required (Carnoy et al., 2015).

Furthermore, Azuka and Kuruma (2015, p. 47) mentioned that "what the teacher knows and does can make a difference to the education of a child". This was in support by Hodenfield and Stinnet (1961) that if a teacher lacks content knowledge, s/he can create a loss to the future education of a child that cannot be easily repaired. So it is very important for teachers to be aware that whatever they do in each and every minute in their classrooms has a serious impact towards the future of a child. Ginsburg et al. (2008, p. 3) confirmed that primary teachers are "poorly trained to teach the subject, afraid of it, feel it is not important to teach and typically teach it badly or not at all". This then leads to primary learners entering secondary mathematics without the necessary required skills in mathematics.

2.10.3. Policy documents having lot of mistakes

In South Africa challenges in mathematics are not fully dealt with because they add up to one another. Bennie and Newstead (1999) spoke of challenges identified by Mathematics Learning and Teaching Initiative (MALATI) in the Western Cape from the Curriculum 2005 policy document where performance standards did not link with the range statements, and further some of the contents not being suitable to the phases offered. Even Monteiro and Pinto (2005) mentioned the education policy to be a possible factor which brings a gap between public and private schools in Brazil. Noting that it is of importance for subject policies to change as they are "influenced by the change in the economy and social worlds, historical events and trends, and new developments in technology and science" (Pejouhy, 1990, p. 8), but it is of utmost importance to ensure that these policies are in line with what is required by the current society.

Similarly, in Scotland, Smith (2004, p. 1) also complained about the failure of the then curriculum to bring interest and motivation. Also in Wales, England and Northern Ireland, the curriculum failed to "meet the needs of many learners and to satisfy the requirements and expectations of employers and higher education institutions". Li (2015) complained of high school curricula in China which kept on being reformed, but leaving the teaching of college mathematics as it was, not aligned to what was happening in schools. Nothing seems to be done with regard to the challenges found in these policy documents, or what is done to remedy the situation seems to be not helping. Now such challenges are left with teachers to manipulate around in the classroom. Moreover, Bennie and Newstead (1999, p. 153) said when "teachers are trying to come to grips with the content in the existing syllabi, it is clear that the introduction of the topic is going to place a greater burden on these teachers." This refers to introduction of new topics in mathematics onto the existing ones (Mack, 1961) which teachers are still struggling to communicate them well to learners.

The use of policies does not guarantee good quality of teaching (Hill et al., 2014), and the mistakes in the policy documents cannot be fully associated with underperformance. It is important to ensure that there is a "challenging mathematics curriculum that prepares student to face the current society" (Teaching Mathematic, 2006, p. 9). It is indeed disturbing to find the department allowing a textbook to be published and recommended for learners to use, but having a lot of mistakes (Pia, 2015). It is further important for the Department of Education to revise the policy earlier than expected, especially if there are errors that have been identified from such policies.

2.10.4. Teachers' and learners' lack of interest in mathematics

Other authors like HMIE (2009) and Mbugua, Kibet, Muthaa and Nkonke (2012) emphasised that lack of interest of a teacher towards mathematics would always have a negative impact towards the interest of learners in the subject. On the other hand, Ghorpade and Rota (1996) added that good attitudes of teachers may always shape learners' attitudes towards mathematics. So if teachers lack motivation, they might fail to bring interest to learners and to have the love for mathematics, hence no learning takes place in their classrooms. Even Karpati, Fazekas, Kollo and Uarga (2009, p. 205) said "teachers must be able to shape students' personality", and to be able to achieve this begins with having interest in what one does.

The lack of interest of mathematics in teachers, which further affect learners, leads to the "decline of young people continuing to study mathematics" (Smith, 2004, p. 3), which also leads to mathematics being rated number seven with regard to interest from the nine subject, and fourth for difficulty in England (Bishop & Nickson 1983), hence there is shortage of mathematics specialists just like in South Africa presently, or even shortage of mathematics teachers. Schleicher (2007, p. 35) emphasised that "if you do not have inspired teachers, how can you have inspired students". It is also important to have passion in teaching (The Scottish Government, 2014). On the other hand, Farooq and Shah (2008, p. 75) also mentioned that the lack of interest in learners towards mathematics "plays a crucial role in the teaching and learning process of mathematics". So lack of interest towards mathematics in teachers has serious negative impact towards learners, which leads to learners not being interested in doing mathematics, and for those who are doing mathematics, not performing well in the subject. Teachers are supposed to be motivated so that the results in mathematics would improve (Schleicher, 2007). Having interest in what teachers teach would play an important role of encouraging all learners to learn and acquire the knowledge and skills required and further exhibit their potentials (The Scottish Government, 2014).

Gourneau (2005) stated that the good attitudes of a teacher reveals genuine caring, kindness, willingness to share the responsibilities, sincere sensitivity to learners' diversity, motivation and enthusiasm. Vialle and Tischler (2009) added to the above list of personalities required from an effective teacher as having the sense of humour, be culturally responsible, be willing to make mistakes and having an insight in cognitive, emotional and social needs of learners. This proves that a teacher's personality also plays a vital role in the education of the learners. Lee and Johnston-Wilder (2016, p. 2) spoke of the need for "mathematical resilience" which is all about the positive attributes, which "prevent negativity in teachers" and assist learners to learn cooperatively with others, and further enables them to apply mathematics even outside the classroom. The most important issue is to change the perceptions that people have with regard to mathematics (Ellerton, 2014). Until such time that teachers, learners and the whole society are freed from the negative thoughts in mathematics, then we shall never reach a state where learners become interested in mathematics.

2.10.5. Lack of support to student teachers and practicing teachers

Boston and Wilhelm (2015, p. 27) emphasised that the support from teachers to learners can "maintain students' opportunities for thinking, reasoning and problem solving". Teachers are unable to provide learners with the necessary support required because they too are not receiving any support from the Department of Education. Most teachers go into the field work and never receive adequate support, which leads to some of them quitting the system, and those who fail to quit, remain frustrated and struggling in schools, and further take out their frustrations to learners (Fantilli & McDougall, 2009). Weber (2012) emphasised the need for lecturers to support student teachers to plan their lessons, observe them when teaching and assist them to improve their lessons to be better next time. This can only be possible if student teachers are offered enough time to be in the schools during training (Schleicher, 2007).

Furthermore, Chiu and Churchill (2015) found that graduate teachers always struggle to manage their classrooms in their first years of teaching. Global Campaign for Education (2012) emphasised that educators' classroom management strategies do play a significant role to the learners. So it becomes a serious challenge if a teacher is unable to manage the classroom, and further no one seems to be willing to assist such a teacher in anyway. Teachers come to schools unsure of how to go about working with learners because they are not thoroughly trained (Loewenberg, Hill & Bass, 2005). In doctors' profession, I believe it is not allowed for a newly graduate doctor to operate a patient without the assistance or monitoring of a more experienced doctor. Why can't the newly employed teachers be assisted or monitored by the more experienced teachers?

The connection between what teacher training offers differs to what teachers are supposed to do in the classroom (Schleicher, 2007). These teachers therefore remain confused and frustrated (Fantilli & McDougall, 2009), and this affects learners negatively. Teachers who have long been in the system are also not supportive of the new ones. It might also be possible that their reasons for not assisting the new ones are that, they too arrived in schools frustrated, no one was there for them, and only experience assisted them. But while the new teachers are still struggling and waiting for experience to teach them how to manage the classroom, learners are suffering because no learning would be taking place. On the other hand, United Nations Education Scientific and Cultural Organisation (Klees, 2014) mentioned lack of teachers in schools, which results in high learner teacher ratio in the classrooms, and too much workload to teachers (Karigi and Wario, 2015), which still reveals lack of support supplied to teachers. If the Department of Education does not ensure that educators do receive all the necessary support required to ensure quality education, it is then failing our education system.

2.10.6. Poor teacher training

A lot of issues have been raised on a daily basis about the types of teacher training that our countries have. Kukla-Acevedo (2008) mentioned that teacher training has important implications for the future success of teachers in the classroom. In addition, Schleicher (2007) mentioned a need to provide teachers with skills in the early years of the training, and further continued to say there was a need to move training systems from the lecture theatre to the classroom situation. Ali (2011, p. 60) also mentioned that teachers do not have “command over subject matter knowledge in mathematics”. This is due to poor teacher training that teachers have gone through, which led to teachers teaching the wrong content to learners, and surely being one of the reasons why learners underperform. Teacher education programmes “should reconsider how they provide subject matter knowledge and opportunities to teach it” (Borko, Eisenhart, Brown, Underhill, Jones & Agard, 1992, p 197). Hence Farooq (2013, p 14) raised the question, “What is the use of training if teachers have no expertise in practise of skills and methodologies?” If teachers are not well trained when they complete their studies, and are supposed to face the reality of being alone in the classroom not knowing what to do in front of the learners, further not receiving any support within the field of teaching, such teachers frustrate learners. There is a need for development of effective strategies developed when training teachers (Da Ponte & Chapman, 2007). After training, teachers should be creative, inventive, have theory and philosophy in various concepts of education (Farooq, 2013).

In addition, Loewenberg et al. (2005) mentioned that teachers are graduates of the system that needs to be improved. This was in support of Da Ponte and Chapman (2007, p. 23) who stated that teachers still “need further learning to carry out ‘better’ practices”. Hence there is a belief that success of a teacher lies within continuous professional development, which is believed to be able to assist in some of the challenges teachers encounter in their classrooms (Education and Culture, 2011). Farooq (2013) mentioned the need to re-orientate our trained teachers. While this is the case, Turner (2008, p. 113) mentioned that it is “possible to help teachers become practitioners who are able to engage more effectively in critical discussion within … wider profession”. But, according to Vithal (2008, p. 29), even if there were developments done to try and modify teacher training, yet, “very little is known about what it means to prepare teachers for such approaches”. It seems our teachers are “highly trained but uneducated” (Farooq, 2013, p. 10), because, according to Farooq, there is a difference between training and educating a teacher. So there is a dire need for teacher education systems to improve their practices. But it seems we still do not have a model that more excellently organises pre-service teachers to be ready to teach mathematics (Strawhecker, 2005).

Even if it is necessary for teachers to continuously develop themselves professionally (Leu, 2005; Wong, 2007; Slavin & Lake, 2007; Qablan, Mansour, Alshamrani, Aldahmash & Sabbah, 2015), it may be of no use if already their undergraduate qualifications failed to provide them with skills that endure their confidence in the classrooms. In addition, lack of content knowledge leads to lack of confidence in teachers. On the other hand, Qablan et al. (2015) further spoke of low participation of teachers in continuous professional development not being due to lack of interest in teachers, but due to contextual factors like professional development campuses being far away to be easily reached by teachers, and also the time allocated for them to attend being unsuitable.

It is said that learner-centred classrooms are useful to ensure that learning takes place in the classroom (Prendergast & O'Donoghue, 2010; Batten, 2011), but it seems teachers are not taught during their training period how this practice can be done. Lefoka and Sebatane (2003, p. 18) mentioned that in Lesotho in teacher training institutions "lecturing is a predominant method of teaching", which leads to graduates also lecturing in the classroom, which is contrary to what is said to be working well for learners, i.e. learner-centeredness. In Botswana it was found by Major and Tiro (2012) that too much theory was taught to student teachers than teaching practice. It should always be known that teachers are trained to be able to "face uncertain and unexpected situations in and outside the classroom" (Farooq, 2013, p. 12).

Lecturers are supposed to be practising exactly what they expect the trainees to be doing in future. Education and Culture (2011, p. 13) listed a number of things a teacher training should provide, and that list included "provision of students with skills and abilities to apply various methods of teaching, implementation of new technology in education, plan and carry out education activities", and many others. If what is expected from teachers is not taught during training, where do we expect the teachers to acquire the skills needed from? Also the curriculum at the trainings should in a way link to the secondary mathematics curricula (Li, 2015), which would then ensure that teachers are not frustrated on what to do when they arrive in schools. Poor teacher training leads to lack of “original and creative teachers who are able to face unpredictable situations within and outside the classroom” (Farooq, 2013, p. 14). Performing places like Boston and Japan mentioned that their teacher training systems allow teachers to spend more times in the classroom (4 days in a week) (Schleicher, 2007), because that is exactly what the teacher should master, and further provide hundred hours to teachers to continue with professional development programmes (Schleicher, 2007). This seems to be showing support to teachers.

2.10.7. Mathematical myths

There is a myth that learners come from their various backgrounds of mathematics being a difficult subject (Pia, 2015), which was further observed to be true in England when mathematics was rated the fourth difficult subject (Bishop & Nickson, 1983). The way in which the society as a whole is failing to eradicate the challenges in mathematics keeps on maintaining this myth and making it a reality. If since the beginning of schooling years of a child mathematics was underperformed, and still today that is still the case, therefore the myth that mathematics is tough would never go out of the mind of children.

Another myth mentioned by Pejouhy (1990) is that mathematics is demanding and only a few can understand it. This is similar to the one above that mathematics is tough. Hence even in today’s classrooms one may find teachers only teaching learners the basics because they believe advanced mathematics cannot be understood by all learners (Pejouhy, 1990). It is supposed to be the responsibility of all stakeholders in mathematics to ensure that everybody understands the perception of what it means to know and do mathematics (Borko et al., 1992), the roles of mathematics in the society, and further ensure that there is equity in mathematics education (Ellerton, 2014). If all people do understand the importance of mathematics as mentioned earlier, it would even become easier to remove the myths that the learners, the society and some teachers have about mathematics because they would be aware that anyone can do mathematics and further perform even more than expected.

2.11. Qualities of an effective mathematics teacher

2.11.1. Personality of a teacher

Hill et al. (2014, p. 12) mentioned a gap in research regarding "how the teacher's personal characteristics relate to institutional quality". Rahman et al. (2011, p. 151) mentioned that the training of teachers should be able to "mould the personality of a teacher such that their attitudes are reshaped, their habits are reformed" and further be willing to live a professional life. There is a need for teacher training that can "deepen the teaching philosophy of 'active and brave' in exploration" (Li, 2015, p. 219). A lot of blame has been put to teachers when learners are not performing well, but the way in which they have been trained becomes a contributing factor.

It seems there are a lot of expectations in mathematics that an individual mathematics teacher is supposed to do to ensure that the subject is effectively taught. "Exploring what constitutes effective teachers in bringing about success in school mathematics becomes important to understand" (Jorgensen & Lowrie, 2015). In Singapore and Finland, Schleicher (2007) mentioned that even the society values the teaching profession to be the one bringing greater contribution to them more than any other profession. What constitutes an effective teacher becomes a necessity nowadays. We learn from Fantilli and McDougall (2009), Ghorpade and Rota (1996), Milwaukee Mathematics Partnership (2008) and Adams (2012) that being motivated, having confidence, flexibility and good attitude towards mathematics are of importance for one to become an effective teacher. Schleicher (2007, p. 18) added: "strong interpersonal and communication skills, willingness to learn and motivation to teach" also serve as good personalities of teachers required to produce better results.

Moreover, Ferguson (2010) listed seven C's, amongst which there is a need for a teacher to have care, control and provide clarity to learners. A teacher is supposed to be a role model, enthusiastic, creative, hard-working, reflect on his own practices and have attitudes and beliefs to adapt and to respond to changes (The Scottich Government (2014). So before one can mention all the other required skills in mathematics, it is important for the mathematics teacher to have a personality which includes the listed characters above. So what would then happen if a mathematics teacher as an individual lacks one of the characters above? Can such a teacher be in a position to become an effective teacher? The passion for teaching should be the first priority in a teacher (The Scottish Government, 2014).

2.11.2. In-depth knowledge of the content

Hodenfield and Stinnet (1961) and Azuka and Kurume (2015) stated that the knowledge of a teacher and his or her practices in a classroom can make wonders to the children's education, but what the teacher does not know can create a loss that cannot be repaired. This emphasises the need for a teacher to have an understanding and an in-depth knowledge in the content he or she is teaching (The Education Alliance, 2006; Pejouhy, 1990; Anthony & Walshaw, 2007; Adams, 2012; Ekmeckci et al., 2015; Kaino, 2015). Moreover, "mathematics knowledge is widely acknowledged as one of the critical attributes of mathematics teachers" (Da Ponte & Chapman, 2007, p. 7). Schoenfeld (2012) mentioned that the teachers' success or failure is determined by the knowledge s/he has. On the other hand, Ball (1960, p. 243) said the most important thing in mathematics "is not just what mathematics teachers know, but how they know it and what they are able to mobilise mathematically in the course of teaching".

Most teachers only seem to be relying on learners' textbooks (Jung, Mintos & Newton, 2015) even if they have provided examples which are in the context unknown to learners. Lack of content knowledge in teachers is the reason to their failure of contextualising the mathematical concepts found in textbooks. The teacher is only expected to use a textbook as a source of reference (Jung et al., 2015). Civil (2008) cited an example of making use of the learners' knowledge of money to enhance their learning of arithmetic with whole and decimal numbers, which is something available and used in the context of their daily living. Burton et al. (2008, p. 2) found that "the higher the mathematical content knowledge of the teacher, the higher the achievement of their students".

Sibuyi (2012) added that the knowledge of the subject cannot alone be regarded to be enough to ensure that learners understand mathematics, but also the ability of the teacher to know the types of learners they are teaching. Knowing learners according to Sibuyi (2012, p. 1) can enable the teacher to identify learners' conception and misconceptions, which may then ensure that learners "gain the indispensable mathematical reasoning required in life". The teacher serves as the centre of knowledge to his class (Pejouhy, 1990), and so imagine if teachers still have inadequate knowledge on the content; they might never have a chance to know the learners they teach. Hence, the classroom environment is inactive and probably with no learning taking place. Schleicher (2007, p. 35) also said "you can have the best curriculum, the best infrastructure, and the best policies, but if you don't have good teachers then everything is lost". This implies that unless our teachers do gain the necessary skills and knowledge required including having an in-depth knowledge, there is nothing that can assist us with the education systems we currently have.

2.11.3. Planning of the lesson

A number of studies have stressed the issue of planning a lesson to be helpful in providing quality instruction (Fraser, Garofalo & Juersivich, 2011; HMIE, 2009; Doerr, 2010; Siraj-Blatchford, Sheperd, Melhuish, Taggard, Sammons & Sylva, 2010). In addition, the lesson plan is supposed to be logically arranged with multiple representations (Long, Newman, Acker, Siders, Swoszowski & Horn, 2015) by making use of various teaching methods (Fraser et al., 2011; Prendergast & O'Donoghue, 2010) which cater for all kinds of learners. Tall (2011, p. 23) came up with the three worlds of mathematics, where he named one to be "formalism", which is said to be offering "precise logical deduction that [would] work in any context". The logical deduction can be observable if the lesson is well planned, and with inclusive education, it is indeed necessary for a teacher to be able to apply various skills when teaching to cater for all the learners.

Bakar et al. (2010, p. 393) emphasised that the teaching of mathematics "require[s] comprehensive planning to ensure quality education" and to ensure that there is a sequence in mathematics tasks (Bokhove, 2014). But still, there seems to be unstructured lessons observed in the classrooms that lead to inability to manage time (Lefoka & Sebatane, 2003). The possibility that teachers are trying to implement a lot of what is required of them is very high, but so confused on how to implement. The Scottish Government (2014, p. 9) emphasised the need for a lesson to be “relevant, creative, interesting and accessible”. The way in which the teachers plan their lessons speaks a lot of what the outcomes would be.

2.11.4. How teachers are supposed to teach

“Teaching is one of mankind’s most important achievements” because “it allows cumulative human culture to exists and enables us to have a history” (Strauss, Calero & Sigman, 2014, p. 1). Bass (2005, p. 430) once mentioned that “knowledge needed for teaching is different from that needed for other occupations or professions where mathematics is used”. This was supported by Niess, Van Zee and Gillow-Wiles (2010, p. 43) who stated that there is a “need for overarching conception of what it means to teach a particular subject” and also “knowledge of instructional strategies and representations for teaching particular topics”. There is a need for teachers to have “high-level instructional tasks” (Boston & Wilhelm, 2015, p. 27) and also the “ability to balance student needs with the needs of society and of mathematics itself” (Pejouhy, 1990, p. 9). Walter and Briggs (2012, p. 6) also said “good teaching makes a difference to learning”. Moreover, Borko et al. (1992, p. 217) said teaching mathematics effectively requires “knowledge characterised by an explicit understanding of the principles and meaning underlying mathematical procedures”.

A teacher is firstly expected to maintain discipline in the classroom (Phillipp, 2010), which Chiu and Churchill (2015) mentioned that it is a struggle to the newly graduate teachers, as they are also expected to be able to use various mathematical teaching techniques, and make a link or a connection amongst the mathematical topics (Ball, Ferrini-Mundy, Milgram, Schmid & Schair, 2005; Siraj-Blatchford et al., 2010; Chiu & Churchill, 2015), and further show how the knowledge in mathematics relates to other learning areas (Mathematics Teacher Guidelines, 1999). Karpati et al. (2009, p. 205) spoke of the ability of a teacher to “develop skills and competencies that are needed in a knowledge-based society”.

In addition, mathematics problems should be made to be in real life situations that are suitable for environment learners to find themselves in (Victoria University, 2008; Murray, 2011; Pia, 2015), and further the teacher should have problem solving strategies, and ensure that learners also acquire such skills (Pejouhy, 1990). A teacher can only be able to make mathematical problems related to real life situation, and also link topics only if such a teacher has mastered the content and found ways to manipulate the subject content to be meaningful and accessible by learners (Manouchehri, 2009). On the other hand, a challenge might arise if teachers are not aware of the reasons behind adopting new teaching methods, which might lead to them being resistant to change and continue with their old ways of teaching (Khan, 1994; Lefoka & Sebatane, 2003).

2.11.5. Prior knowledge and assessment

It is believed that for children to be able to grasp a new concept introduced to them well, there is a need for a teacher to search for prior knowledge (Larson, 2002; Takahashi, 2009; Ontario Ministry of Education, 2007; National Research Council, 2011; Hill et al., 2014; Long et al., 2015). The knowledge that students have before being introduced to a new concept assists the teacher to be able to identify misconception that the students might be having with regard to that new concept. The National Research Council (2011) further believes that this prior knowledge provides learners with experiences and arouses their interest because they are also making a link to what they already know, to a new concept that was being introduced to them. The challenge comes when as a teacher you expect learners to be having certain basics with regard to what you are supposed to introduce and find that learners do not have such basics. This would then mean one has to go back and teach those basics because without them, it might be a challenge for learners to understand what was supposed to be introduced, which then has an effect on managing time, and also leads to non-completion of the syllabi.

Also, an ongoing assessment of learners has been emphasised (Department of Education, 2010; Maccini & Gagnon, 2011) to assist the teacher diagnose the challenges that might hinder learning along the way (Al-Qaisi, 2010). Most teachers are still used to the old methods of teaching, where a teacher only talks in the classroom and the learners listen, and the teacher would assess learners with a classwork at the end of the lesson, and possibly again with a test at the end of the month. This then leads to teachers realising that learners did not understand some concepts well at a very late stage, and due to time factor, fail to go back to re-teach whatever that the learners missed. Learners are supposed to be assessed on an ongoing process (Department of Education, 2010; Maccini & Gagnon, 2011) to ensure that the misconceptions are picked up at an early stage.

2.11.6. Ability to make use of correct mathematical language

It is important for a teacher to be able to make use of the correct language required in mathematics (Malden, 2009; Bakar, et al., 2010; Portman & Richardson, 2012). Portman and Richardson (2012) added that in mathematics, both ordinary language and special mathematical languages are supposed to be used. Some of the difficulties that the learners encounter in mathematics has been the misunderstanding of the language used; so if teachers could ensure that the learners are familiar with mathematical language, certainly language may not be a barrier to learning. Anthony and Walshaw (2007) mentioned the need for a teacher to model the necessary vocabulary and ensuring that learners do understand the language used. The wrong use of language in mathematics may mislead learners to misinterpret what the teacher wanted them to understand. The Department of Education and Early Childhood Development (2010) further stressed the need for teachers to emphasise the correct use of mathematical language and symbols to learners, and the ability to connect the language, symbols and materials.

2.11.7. Team work

Team work refers to co-teaching, which has been observed when “two or more people [are] sharing responsibility for teaching some or all of the students assigned to a classroom” (Cushman, 2004, p. 5). There has been a need for mathematics teachers to engage in co-teaching. “Successful co-teaching calls for active involvement of both teachers in the task of instruction” (Rytivaara & Kershner, 2012, p. 1001), and the sharing of the work must be beneficial to the learners. The challenge observed was that it seems teachers are unable to put co-teaching in practice ((Rytivaara & Kershner, 2012). A mathematics teacher must be in a position to collaborate with other mathematics teachers (Lim, 2007; Hill et al., 2014). This has been proven to be enabling production of better results in some countries (Global Campaign for Education, 2012).

Co-teaching can further allow a teacher to ensure that in his or her classroom, not only him or her as a teacher works with other teachers, but learners too do work together. It may assist learners to be aware that their teachers are solving mathematical problems together, and therefore encourage them to work with their peers. It is believed that effective teaching would be achieved when teachers share characteristics of their abilities in teaching (Da Ponte & Chapman, 2007). This may make collaborative learning be strengthened (Prendergast & O'Donoghue, 2010; Batten, 2011) and an easy method in the classroom, and will therefore make lessons to be more learner-centred (Peng & Nyroos, 2012) which would bring active participation in learners.

But, Lefoka and Sebatane (2003) have learned that even where teachers have been practising collaborative learning in their classrooms it was seen to be un-organised, unguided and unsupervised. Hence, Boston and Wilhelm (2015, p. 27) emphasised the need for "highly quality whole class discussion". Even if teachers are willing to practise collaborative learning in their classroom, there seems to be a lack of knowledge on how to implement it. So one does realise that South Africa is still far from having "high quality teaching", which can only be made possible if there are "high quality teachers" (Global Campaign for Education, 2012, p. 10).

2.11.8. Use of technology

A number of studies have mentioned the use of technology in mathematics classroom (Moursund & Albrecht, 2011; Pia, 2015; Swee, 2015; Teo & Milutinovic, 2015) to be of assistance to teachers. Watson (2015) emphasised building of deeper understanding in mathematics being brought by technology. On the other hand, Karpati et al. (2009) mentioned that teachers must be in a position to use different technologies in their classrooms. I believe that technology may be of better assistance in the mathematics classroom, but it may not eradicate the challenges faced in mathematics, especially issues related to poor performance. My belief is that technology can reduce the amount of work that a teacher is faced with as the subject has been having a lot of practical work to be done, like sketches,. Technology can help, but it can never ensure that teachers teach effectively. On the contrary, Teo and Milutinovic (2015) complained of teachers' attitudes towards the use of technology to be a disturbing factor for implementation.

2.11.9. The need for continuing professional development

There has been a need for a mathematics teacher to engage on continuing professional development (Deshler et al., 2015; Dreher et al., 2015), which may "equip teacher to achieve high levels of implementation and discussion" (Boston & Wilhelm, 2015, p. 27). Out of all the characteristics of an effective mathematics teacher listed above, the continuing professional development might at most of the times equip the teachers with what they are supposed to do and how (Education and Culture, 2011). Educators are supposed to be taught secondary mathematics contents like algebra, geometry and trigonometry. There has been a need for teachers to "develop a disposition of inquiry and a professional attitude that allows them to continue to learn from practice" (Manouchehri, 2009, p. 5), which requires teachers to reflect on their practices, and would therefore assist them on their needs to develop professionally.

Sometimes there would be a challenge of being unable to understand the problems the teachers are faced with, hence there seems to be professional development programmes that are not relevant towards the needs of the teachers (Schoenfeld, 2012). There is a need for in-service training that meet the demands of individual teachers, that would also "improve and develop skills and abilities in order to respond successfully to changes in education and apply new technologies" (Education and Culture, 2011, p. 14) which are also "concrete and classroom based" (Walter & Briggs, 2012, p. 3). Some educators cannot even type mathematics symbols, or even make use of a calculator, it is important for professional developments programmes to include such lessons. Lachance and Confrey (2003, p. 131) mentioned that combination of "teacher 'teaming' in professional development setting with teachers' exploration of mathematical content [proved to be] improving mathematical instruction".

If professional development programmes are not resolving the problems that the teachers have in schools, therefore teachers would not see the necessity of engaging in them. Global Campaign for Education (2012, p. 13) stated that “teacher skills and competencies are acquired through high quality teacher training”. It has been of most importance for teacher training to be in line with what was required in schools (especially the content they are going to teach) so that those teachers who develop themselves gain a lot from the systems. In Belarus, it is “the right and obligation” for a teachers to continuously develop themselves (Education and Culture, 2011, p. 14). In addition, Lachance and Confrey (2003, p. 131) further said that the professional development needs to be structured in such a way that it supports “subsequent changes in curriculum and proposed teaching innovations.”

2.12. What is today’s mathematics teacher?

Looking at mathematics and the way it is growing (Sarton, 1936; Mack, 1961; Krantz, 2010; Ellerton, 2014), the list of the characteristics and skills required for one to be an effective secondary mathematics and further considering the possibilities for an individual’s ability to have all the required skills coupled with the qualities needed, I am bound to believe that an individual mathematics teacher of today cannot be regarded as a good source of knowledge in all concepts of mathematics. There seem to be a need for more than an individual (Sarton, 1936) to ensure that the underperformance in mathematics is reduced. It is true that there are multiple reasons why secondary mathematics learners underperform, and a lot of them have already been addressed in this chapter from a number of studies, but still there are expectations to what a mathematics teacher is supposed to be.

Vialle and Tischler (2009, p. 115) asked the question, “Are effective teachers born or can they be made?” Looking at a number of qualities required for one to be an effective teacher, I believe it might be impossible to say a person can be born with all the qualities mentioned earlier. If the qualities can be taught, are they not too many to be grasped by one person? In my opinion, an individual might be strong in some qualities and weak in others. So mathematics teachers of today are faced with a challenge of shaping their personalities. Even if there are those who might be having all what is required in a mathematics teacher, which in my view is impossible because the subject itself is impossible to be put in a single being (Sarton, 1936), the growth in the subject, however, would still remain a challenging factor.

2.13. Conclusion

The theoretical framework of the study, what the word embodiment mean, who is referred to as a secondary mathematics teacher, how mathematics originated, formation of schools, what mathematics is, and the developments of how a teacher has been modified with time have been outlined in this chapter. Also the way in which authors defined mathematics and its impact to the society have been mentioned. Further, the growth in mathematics and the reasons to this growth have also been emphasised. All these were to highlight the issues related to what we expect today of a secondary mathematics teacher.

The requirements of what was expected in a mathematics teacher together with the challenges this teacher was facing were mentioned. This was to support the fact that the notion of a secondary mathematics teacher we currently have is no longer suitable to embody what is expected as an effective secondary mathematics teacher. The subject itself is just too large to expect a single mind to grasp (Sarton, 1936). Lastly the implications towards the notion of a secondary mathematics teacher was strengthened and supported by the literature that an individual secondary mathematics teacher we currently have no longer serves as a suitable notion to embody the expected secondary mathematics teacher, because such a teacher has no capacity to embody a gigantic subject like mathematics.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

In this chapter the research design adopted, selected methods of sampling and the methods used to collect data have been explained and further clarified how they have been of importance in this study. Also, the way in which data was analysed has been outlined and the types of analysis selected have been mentioned. Moreover, the ways in which credibility, authenticity, bias, transferability and ethical considerations have been ensured with a table indicating the number of sources used. The main focus in this chapter is to ensure that all research procedures are correctly followed, making use of studies which used similar designs.

3.2. Research design

This was a qualitative research design and grounded theory was used as one of the designs from qualitative research, as it has also been mentioned by Bitsch (2005, p. 77) that grounded theory "is the master metaphor of qualitative research". Grounded theory was defined as a "methodology that researchers use to develop theory inductively from data" (Glaser et al., 1967, p. 5) where creation of analytic codes and categories are developed from data by pre-existing conceptualisation (Calman, 2006). Gillian et al. (2013, p. 130) also maintained that "grounded theory seeks through to generate theory rather than to prove or disprove it", which was another part of the cognitive dissonance (Festinger, 1962). In addition, Glaser et al. (1967) added that grounded theory was derived from data sources of a qualitative nature, but can also employ quantitative methods.

In this thesis, grounded theory was descriptive in nature, which allowed the intimate connection between the researcher and what was being discovered (Walshaw, 1995). This descriptive nature of grounded theory catered for what Elliot and Higgins (1992, p. 5) called "Foucault theory of power", where the emphasis was to do preliminary review of the literature, which would then bring connection to what the researcher had in mind about this study, to what other studies said, which also formed part of the cognitive dissonance of Festinger (1962). There was continuous reflection on what the study was about, where articles were gathered, made a story out of them, reviewed the story and made sense out of the story (Calman, 2006). Continuous reflection and arrangement of ideas assisted to allow a theory to emerge, since the main focus in this study was to allow theory to emerge (Gillian, et al., 2013) on the current notion of an embodiment of a secondary mathematics teacher.

Categories were generated and refined (Elliot & Higgins, 2012) as part of the cognitive dissonance (Festinger, 1962) looking at the suitable embodiment of a secondary mathematics teacher in relation to the growth in mathematics as a subject. Furthermore, there were comparison of mathematics teachers of the ancient eras BC, and those of the current era, also considering the growth in the subject in different eras and also the researcher's ideas (Glaser, 1992; Elliot & Higgins, 2012). As theory emerged (Gillian, et al., 2013) about the notion of a mathematics teacher in the past and the present eras, they were compared and further looked at whether what we have today as a secondary mathematics teacher, is suitable to embody the secondary mathematics teacher, which is what Glaser (1998) mentioned, that literature is discovered together with emerging theory, and this is what Festinger (1962) called the cognitive dissonance. The comparison of data is what Fereday and Muir-Cochrane (2006) mentioned to be assisting in revealing pattern from data.

Document analysis as a qualitative research method was adopted in line with grounded theory. Document analysis is a "systematic procedure for reviewing or evaluating documents" (Bowen, 2009, p. 27) and it requires that data be examined and interpreted to give and develop meaning to gain understanding (Strauss & Corbin, 1994). Glaser et al. (1967) emphasised that there is no way that the researchers could erase the knowledge they had in mind before the study, therefore document analysis brought meaning to the researcher's knowledge. The researcher's knowledge about a mathematics teacher was then compared to what the other authors wrote about a mathematics teacher, which is what the cognitive dissonance by Festinger (1962) required. The study therefore employed qualitative methods of data collection. According to Glaser and Strauss (2009, p. 18), qualitative study is often the "most adequate and efficient way to obtain the type of information required and to contend with the difficulties of an empirical situation".

3.3. Sampling

This was a desktop study, and to have an overview of the evolution of the embodiment of a secondary mathematics teacher, theoretical sampling was adopted. Theoretical sampling is purpose driven to explicate and refine the emerging theory, and further focus on data that were "sufficiently and significantly relevant to the core category and its related categories" (Breckenridge & Jones, 2009, p. 116). As theoretical sampling becomes purpose driven and only selects relevant sources of data, it leads to what Elliot and Higgins (2012) called classic theory, which is initially inductive as it builds theory, and then is made wholly inductive by ignoring its deductive components during theoretical sampling. Selection of relevant sources of data was required by cognitive dissonance of Festinger (1962). It was further highlighted that through joint theoretical sampling and memo writing, categories can be generated, corrected, trimmed and continually fitted to the data (Glaser, 1978). The analytical memo would assist to capture and track ideas such that the researcher could also document his/ her own non-grounded ideas about the emerging theory (Glaser, 1998).

Published journals and books from eras where mathematics and a mathematics teacher were observed were sampled. They were selected because of their relevance (Strauss & Corbin, 1990; Breckenridge & Jones, 2009) with regard to issues at hand about a mathematics teacher, and only a few representing an idea were selected (Breckenridge & Jones, 2009), which is what Elliot and Higgins (2012) referred to as making a classic theory wholly inductive, since the study was not interested in making generalisations as in quantitative studies. In this study the sampled books and journals were there to highlight issues related to the study, not to make generalisations. This means that the articles were skimmed to check if they contained issues related to the study (Breckenridge & Jones, 2009), and if so they were further checked which periods they represented, and then sampled to be used in the study. In some cases, a journal or a book can be of present era but focussing on issues of the ancient era, such documents were also sampled and represented the ancient eras they focussed on. This was due to the fact that most books and journals of ancient eras could not be accessed. Then the sampled ones were sorted according to the idea and the period they represented as emphasised by Bowen

(2009), to allow the ability to access meaning and understanding (Strauss & Corbin, 1994).

The theoretical sampling was used using memo writing (Glaser, 1978) where codes were derived from the year 800BC to 2015, looking at whether the notion of an embodiment of a secondary mathematics teacher has always been the same in different eras, and if not, how it has changed over time. Furthermore, looking at whether what we have today as the notion of a secondary mathematics teacher would still be a suitable embodiment of an expected secondary mathematics teacher, considering how the subject has grown. The information found from the selected journals and books were further compared to the knowledge and experiences of the researcher (Glaser, 1992) about the current notion of a secondary mathematics teacher.

3.4. Data collection

This was a desktop study whereby literature from various published journals and books were used to trace the evolution of the notion of an embodiment of a secondary mathematics teacher. Creswell (2010) stated that documents are used to help the researcher understand issues that were raised in qualitative studies. Glaser et al. (1967) stated that grounded theory was derived from data sources of a qualitative nature. The use of documents as one of qualitative data collection methods was used in the present study. The selected documents were mostly published journals and books. Although they are known to be secondary data, in this study they served as primary data. Collection of data through published journals and books has been found from the study of Symon and Joseph (2014), though in their study they did not only use documents. They also used interviews. The use of documents led to what Festinger (1962) called cognitive dissonance, which allowed the researcher to use the literature to add knowledge to the experiences and knowledge she had about the notion of an embodiment of a secondary mathematics teacher.

The data was collected looking at the relevancy (Strauss & Corbin, 1990; Breckenridge & Jones, 2009) of the article to the issues addressed in this study.

Furthermore, the periods of the articles started from the dates where there were ancient teachers like the Guru (Rajput & Walia, 2001) to the current teachers, and some of the journals used were without dates, but they were used because they addressed issues about a mathematics teacher in one of the eras that the study focussed on. This enabled the researcher the ability to trace the notion of an embodiment of a mathematics teacher from ancient eras to date; the ability to compare those embodiments to the researcher's experiences and knowledge about a secondary mathematics teacher (Glaser, 1992), and further investigated how the growth in mathematics had affected those embodiments.

The printouts of the documents were made available so that they could easily be accessible for data collection and analysis. The documents were further put systematically for reviewing (Bowen, 2009) so that they could easily be examined and interpreted to provide meaning and understanding (Strauss & Corbin, 1994). The filed journals and books also assisted to do what Elliot and Higgins (2012) called self-correcting process, where the researcher would re-access and re-read data to avoid imposing assumptions, and therefore concluding without allowing theory to emerge as part of Festinger's (1962) theory of cognitive dissonance.

3.5. Data analysis

In analysing data, content analysis and thematic analysis were adopted in line with the usage of documents in grounded theory. Content analysis is the "process of organising information into categories related to the central questions of the research" (Bowen, 2009, p. 32). In this study the books and journals sampled for data collection were organised according to various eras as put in the structure below and further looked at whether they were leading to the answers of the research question posed. Raising a research question at the beginning of the study, and organisation of data into categories was supported by Elliot and Higgins (2012) in grounded theory, and it formed part of Festinger's (1962) theory of cognitive dissonance. Thematic analysis is a form of recognising patterns in data, with emerging themes being made categories for analysis (Fereday & Muir-Cochrane, 2006). Thematic analysis was used to identify commonalities and differences with regard to the notion of a mathematics teacher in different eras, where the main focus was to allow theory to emerge as mentioned by Gillian et al. (2013). The analysis of data was summarised as seen in the graph below:

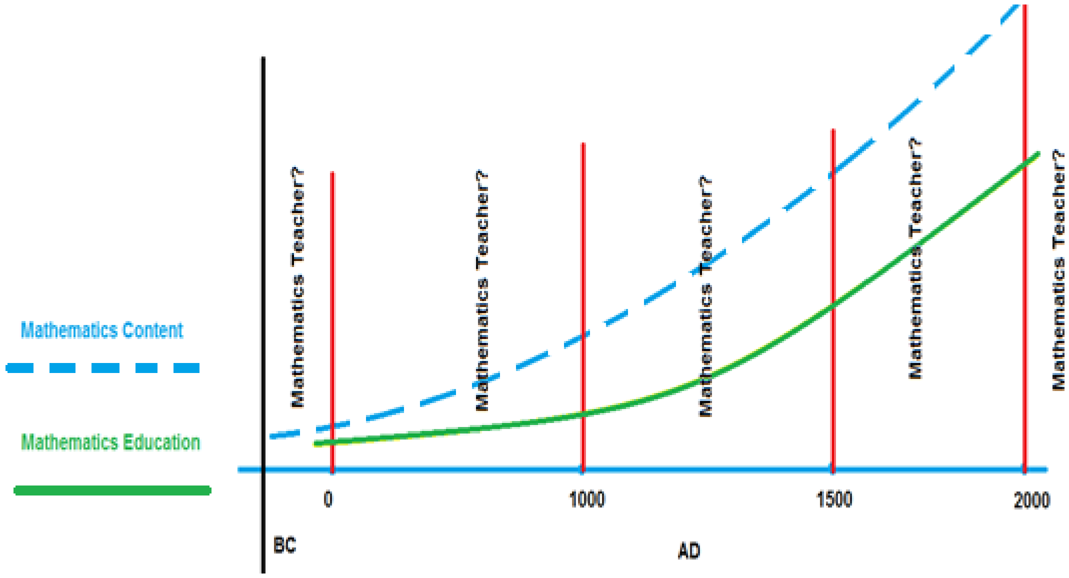

Figure 1: Growth in mathematics content and mathematics education across the eras

The graph served as a picture of how analysis was, though it was not exactly the final aspect. The final structure of analysis emerged as noted by Gillian et al. (2013). Firstly data was divided into groups according to different eras like in the graph above, whereby the growth in mathematics content and mathematics education were traced in those eras. Mathematics content and mathematics education were represented by the two exponential graphs, where the mathematics content was represented by a dotted line, whereas mathematics education was on a solid line. The growth on both mathematics content and mathematics education were compared to the notion of a secondary mathematics teacher in each era, tracing whether the embodiment of a secondary mathematics teacher was still a suitable notion in each era and able to deliver mathematics effectively to the learners, which was what thematic analysis entailed (Fereday & Muir-Cochrane, 2006).

Even though the books and journals for eras of BC could not be accessed, there were those articles which addressed issues that occurred in those eras, and such articles were used to represent those eras. This was done to ensure what Morse (2001) noted, that literature cannot be ignored but rather must support the knowledge and experiences of the researcher, and further be compared to the emerging theories. The question raised in this study was: what is the suitable notion to embody a secondary mathematics teacher? So if mathematics content and mathematics education could be growing exponentially (Sarton, 1936; Mack, 1961; Krantz, 2010; Ellerton, 2014), what about the requirements of an embodiment of a teacher because a teacher cannot grow exponentially? There were three sub-questions posed also to assist in obtaining the answers to the main question, which also included how the growth in mathematics affected the embodiment of a secondary mathematics teacher.

With the kind of analysis above, I tried to emphasise the point that mathematics as a subject was large for an individual teacher to grasp (Sarton, 1936) such that one could offer it properly in an understandable way to learners. The research question and its sub-questions were then answered following the kind of analysis above, where the sub-questions served as the categories formulated, leading to the possible answer to the main question. Since the study was not quantitatively representing the results, only a few journals or books relevant to issues at hand were considered, following what Elliot and Higgins (2012, p. 5) named “Foucault theory of power”, as the theory of cognitive dissonance required (Festinger, 1962), bearing in mind the main idea was to investigate whether the notion of an embodiment of a secondary mathematics teacher that we have today could still be regarded a suitable notion to manage the growing subject (Ellerton, 2014). Is the embodiment of a secondary mathematics teacher of today still the same to what we had in the ancient era, and if not, do we still expect today’s embodiment to teach effectively as the ancient embodiment? Do we also consider how the growth in the subject (Sarton, 1936) could have affected today’s embodiment of a teacher? Krantz (2010) also believed that mathematics has outgrown an individual, but he never questioned the embodiment, and hence this study investigated the suitable notion to embody a secondary mathematics teacher.

3.6. Credibility, authenticity and transferability

The documents are said to be credible as they have been prepared independently and beforehand, not to suit the benefit of the researcher (Mogalakwe, 2006). In this study, the selected journals and books were also credible since they were skimmed to check their relevancy (Strauss & Corbin, 1990; Breckenridge & Jones, 2009) towards issues raised in this study, and those which were found to be raising similar issues were then sampled. Selection of relevant documents assisted to make the study no longer both inductive and deductive, but wholly inductive as mentioned by Elliot and Higgins (2012) as part of the theory of cognitive dissonance by Festinger (1962). The documents were published journals and books, and they were in no way prepared for the benefit of this study (Mogalakwe, 2006) as the researcher only found what they entailed during data collection. There were no alterations done on the documents used to gather information, as also Elliot and Higgins (2012) mentioned that there was no way that the literature could have been known beforehand. Literature was discovered as theory was (Glaser, 1998). All of the information used was directly taken from the original articles to avoid taking false representations of the author, and all hard copies were kept safe to serve as the sources of information to be reused when needed. Elliot and Higgins (2012) spoke of self-correcting process to avoid pet ideas, which was then possible since the documents were safely kept. In addition, multiple journals and books from various civilisations were used in this study. As there was in no way that the researcher would have known what the literature would contain before starting with the research (Elliot & Higgins, 2012), hence even the emerging theory was only determined as the study proceeded, and it was also required by the theory of cognitive dissonance by Festinger (1962).

Table 1 below represents the number of books and journals that were used in the study:

Number of books used	**Number of journals**	**Number of other publications e.g. conference papers, departmental policies etc.**	**Total**
68	94	40	202

Authenticity refers to the "pursuit of truth and knowledge" (Marco & Larkin, 2000, p. 693). Furthermore, Jenner, Flick, Von Kardorff, and Steinke (2004) highlighted that authenticity allows one to select criterion according to the issue at hand in order to achieve findings that are relevant to the study. This was in support of Glaser (1992) when saying that the researcher's ideas should be compared to the literature. Elliot and Higgins (2012) added that this comparison would avoid imposing and concluding without allowing theory to emerge, which has been mentioned to be an important aspect in the theory of cognitive dissonance by Festinger (1962). In this study all the information captured was represented as it was, to ensure the truth in what was found during data collection (Marco & Larkin, 2000), and further ensured that a number of sources were consulted to gain more knowledge on the issues concerned. Ideas of other writers have been acknowledged and referenced to ensure that there was truth in what was said. As Jenner et al. (2004) highlighted, authenticity allows picking of criterion to be regarding the issues at hand, documents were selected looking at what they were addressing, and those that addressed issues relevant to the study assisted to achieve the findings relevant to what was researched.

As for transferability, it has been said to be the extent of having confidence in the results that were obtained (K. K. Stol, J. Stol & Fitzgerald, 2014). Since both the credibility and authenticity were correctly addressed, therefore so was the transferability. This means that starting from selection of document used to collect data, they were in no way tampered with to suit the study (Mogalakwe, 2006), and further the ideas found from the documents were presented as found from their sources (Marco & Larkin, 2000) and also selected because they were addressing similar issues relevant to this study (Strauss & Corbin, 1990; Breckenridge & Jones, 2009), and the combination of all these confirmed confidence in the results found (K. K. Stol, J. Stol & Fitzgerald, 2014). In addition, there was an independent scholar, which is what Baxter and Eyles (1997) called peer debriefing in classic grounded theory, to ensure confidence in the results by consistently interpreting what the implications about the data were as observed from the documents, where need be. Peer debriefing is said to be engagement of a "non-contractually involved peers during the research process" (Bitsch, 2005, p. 83) by assisting with their own perceptions with regard to the findings.

3.7. Bias

Bias is a tendency to prevent unfairness (Pannucci & Wilkins, 2010). To avoid being biased it was necessary to keep on engaging an independent scholar to keep on assisting by interpreting what the author intended to present in their studies. An independent scholar advised on the interpretation of what the other authors were referring to when saying whatever they said, especially where the meaning seemed to be confusing. Engaging an independent scholar is what Baxter and Eyles (1997) named peer debriefing as one of the strategies of classic grounded theory. By doing peer debriefing, I avoided to misinterpret the information from the documents in such a way that might suit the interests of the study, or of the researcher. Furthermore, the documents were read more than once to ensure that at all times after reading, the idea picked was still the same to what was picked when it was read before, which is what Glaser (1998) said would be enabled by creation of analytic memos. Again the issues regarding a mathematics teacher were considered from West, East, Asia, Europe and Africa to ensure that the results found have not only considered a specific context. In this way, the results were fairly presented.

3.8. Ethical considerations

Ethical considerations value privacy as an important aspect (Anonymous, 2007). In this case since the study was a desktop kind of an investigation, whereby the focus was only on interpretation of the literature, which was supported by Elliot and Higgins (2012), there were no direct interactions with people. In this case, the important aspects were to ensure that the literature was acknowledged by referencing correctly. Moreover, the documents were read time and again to ensure that the meaning held by the writer was well captured in this thesis, and also there was a file made to keep safe all the documents used. The filing of documents allowed what Elliot and Higgins (2012) called self-correcting process.

3.9. Conclusion

The chapter has outlined in brief the methods used, designs selected, how sampling was done and also the way in which data was collected. Credibility, authenticity, transferability, bias and ethical considerations have all been defined to ensure that they are correctly addressed in this study, and further adhered to by drawing a table indicating the number of sources that have been consulted in this report. Finally, the literature has been used to clarify how all the aspects in this chapter are supposed to be carried out, as supported by Morse (2001).

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1. Introduction

In this chapter, since the study has been pursuing the question of the suitable notion to embody a secondary mathematics teacher required in the current era, the results have focussed on issues regarding a teacher from collected data starting from era 800BC to the year 2015. To ensure that issues that have been found in various eras are well organised, the eras have been divided into era 1, era 2, era 3, and era 4. Each era focusses on a particular period. The way in which the eras have been divided have not been specific to a particular pattern, but they only consider the common practices with regard to the growth in mathematics content and mathematics education, and the notion of a teacher in those periods. To trace the growth in mathematics, the history of mathematics has been investigated. Each era has been divided into: introductory section, findings and the reflections on what has been found in that era. By organising data into eras made it easier to trace how the notion of an embodiment of a teacher has evolved over time, and also how the growth in mathematics affected this notion. Since this study has not been a history project, only one or two sources have been used from various contexts just as an attempt to pick up some indicators on the issues that are associated with the notion of an embodiment of a secondary mathematics teacher. In the reflection sections, reflections have been done looking at whether the notion of an embodiment of a secondary mathematics teacher in a particular era serves as a suitable notion to teach mathematics effectively. Lastly a conclusion is drawn on the whole chapter.

4.2. Era 1 (800BC – 900AD)

4.2.1. Introduction

In this era, the findings section focusses on the notion of an embodiment of a secondary mathematics teacher and the history of mathematics as found from books and journals sampled during the data collection phase. Only journals and books having information regarding the issues at hand from 800BC to 900 AD have been considered, which Festinger (1962) identified to be making the grounded theory wholly inductive by deducing the data that is irrelevant. Note that there are articles that are not written in this era, but they have been addressing issues of ancient years; such articles have been selected. The idea has been to trace how the notion of an embodiment of a teacher and mathematics growth has been in this era from various contexts. The findings on the notion of an embodiment of a teacher, how this notion originated and its evolution during the years between 800BC and 900AD have been noted. The reflection section has reflected on what has been found as the notion of an embodiment of a teacher, and whether this embodiment has been suitable to those mathematics eras.

4.2.2. Findings

Paul (1994, p. 252) stated that “mathematics concepts and inscriptions predate around 3000BC”. He cautioned that mathematics was not “systematically organised as a discipline until there was a need to professional scribes”. This was in line with Dossey’s (1992) assertion that mathematics nature dated back to the 4th century BC and because of lack of scribes, there was not much of history found around that era even though mathematics existed. Meanwhile, Sarton (1936) took that further and claimed that mathematics had been there in the fifth centuries BC as it preoccupied the human minds even before science.

Moreover, around 30 to 40 thousand years ago, there seemed to have mathematical innovations which led to written language (Fink, 1903). Those were years when pairing of objects were discovered though it was not known exactly in which year (Fink, 1903). Allen (2000, p. 1) indicated that “the human needs that inspired mankind’s first efforts at mathematics, arithmetic in particular were counting, calculations and measurements”. Paul (1994) shares a similar view as he argued that mathematics would not have been there, had it not been the generation of a unit of concepts and their plurality.

Furthermore, Joseph (2011) studied roots of mathematics and found that the ancient Greek mathematics started around 800 BC to 500BC. In those eras there were mathematicians like Thales in 546BC and Pythagoras in 500BC, who studied mathematics in Egypt and Mesopotamia. Again Ball (1960) indicated that the first period of mathematics under Greek influence was in 600 BC to 641AD. However, in Egypt, Aristotle was the cradle on mathematics in 350BC (Ball, 1960). It was mentioned by Eudemus, a pupil of Aristotle, in the study by Ball (1960) that mathematics of Aristotle existed in 325BC though written copies were not found, but from Dossey (1992) it was realised that Plato and Aristotle came up with theory of numbers, logistics and techniques of computation required by businessmen. The first teacher in Greek was a man called Livius Andronicus from Tarentum, who was sold as a slave in the 3rd century, and was employed and served as a teacher for his master's children (Connor & Robertson, 1990). It was further mentioned that the Greeks had schools before the Romans, where the Greeks taught music and athletics in order to have healthy bodies for soldiers (Connor & Robertson, 1990).

Kunen (2007) discovered that the foundation of mathematics consisted of axiomatic method and thus agreed with Joseph (2011) that those foundations were firstly developed by ancient Greeks from 500 – 300BC. According to Kunen (2007), those axioms were not described in detail, and were further described around 300BC by the likes of Euclid. Siegel and Borasi (1996) noted that around the same period there were developments made towards geometries on different sets of axioms than those of Euclid. In addition, Dani (2012), whose study was conducted in India, implied that the context of geometry construction of Vedis was pursued much earlier than it was with the Greeks around 800BC. We further learnt that around 50BC, Gemius came up with mathematical views of methods of proof used by early Greek geometricians (Rouse Ball, 2010).

Furthermore, Tahta (1994) revealed the establishment of irrationality of square roots of non-square numbers up to 17 by Theodorus around 369BC. It was further stated in the very same study that no one knew exactly why he chose the numbers up to 17, but that for some numbers he got stuck, and Theatetus generalised the results (Tahta, 1994). Around 450AD, Ball (1960) reported that Proclus continued the mathematics parts of Euclid on axioms, which was geometry as learned earlier, and also that even the Jain tradition dealt with geometry of circle, and again Dani (2012) also added the arithmetic of numbers etc. In the first centuries After Christ, the second Alexandrian and Byzantine schools were started, where Byzantine came up with magic square of fourth order with sixteen numbers and the sum of numbers in columns and rows being 34 discovered by a man called Moschopulus (Ball, 1960).

This Byzantine discoveries were somewhere between 641 AD and the year 1453 (Ball, 1960).

Literature showed the notion of a teacher from India where Rajput and Walia (2001) spoke of the Gurukula system. With the Gurukula system, the Guru was a teacher who was "the guide, leader, and creator of knowledge as well as the disseminator of knowledge" (Rajput & Walia, 2001, p. 240). It was the responsibility of the Guru to develop a child, and he alone would decide what to teach the child. Learners would go and reside with the Guru and be taught, and the senior learners would be used to teach younger and newer ones (Rajput & Walia, 2001). The Guru was knowledgeable; he had wisdom and no one questioned his knowledge. He was the embodiment of knowledge (Bass, 2005).

In the African culture, there is the concept of *Ngaka* (traditional healer). Though it was not written, people are aware of the way *dingaka* (plural for *Ngaka*) operate and further the way their training is practised. For one to practise as *Ngaka* there should be some form of a calling by the ancestors which may then allow the person to be taken to an existing *Ngaka* to be taught how to become one. The person who has a calling has to live with this existing *Ngaka*, be taught this and that, and when the existing *Ngaka* is satisfied that the person can now be on his own, he then graduates and releases him. Those who have long been living with the *Ngaka* would serve as teachers to these new ones that are being brought to this practice. *Dingaka* are the most important people in the African culture. Even chiefs would go to them for consultation. It is believed that they are somehow closer to the gods, and therefore are in a position to serve as intermediates to the ancestors.

4.2.3. Reflections on the notion of a mathematics teacher in era 1

At the beginning of this era there were developments of mathematics concepts which took place in different places and in an uncoordinated and unrecorded manner. Greeks, Egyptians, Indians, Babylonians etc. were all preoccupied in developing different aspects of mathematics (Dossey, 1992; Joseph, 2011; Ball, 1960, Rajput & Walia, 2001). Education in general was observed but was not yet specific to mathematics as it was the main focus in the study. Some traces of teaching were slightly there as we came across a teacher referred to as a Guru (Rajput & Walia, 2001), although rather unorganised as there were no formal buildings known as schools like we have today. What seemed to be mostly done in mathematics was more of discoveries by mathematicians and not much of teaching of mathematics. A teacher in Greece was mentioned by the name of Livius Andronicus who only taught his master‘s children, but he only taught music and athletics (Connor & Robertson, 1990), and no subject like mathematics was taught. The growth in mathematics content continued as the mathematicians were continuing to discover a lot in mathematics, still, mathematics had not yet reached a stage where it was taught in a formal way.

During era 1 people like Thales, Pythagoras, Aristotle (who came up with theory of numbers, logistics and techniques of computation), Eudemus, Theodorus (who came up with the square roots of non-square numbers), Euclid (who came up with axioms) etc. were mathematicians by nature as they had wisdom and knowledge in mathematics (Davis, 1978). These mathematicians were there pursuing the subject as individuals as there were no institutions like schools; mathematics was not taught as it is today. In their pursuit of different aspects of the discipline, there was no evidence that a separate notion of a mathematics teacher was entertained. Even if there was such an attempt, that notion would not be as universal as it is today. It would have been restricted to a particular aspect in a particular context reflective of the developments there. Hence, it was difficult to talk of a unified notion of a mathematics teacher in this era. So these mathematicians continued coming up with various discoveries which still now form part of the mathematics contents (Ball, 1960, Dossey, 1992; Joseph, 2011). Already there was an observation of mathematics content growing even before mathematics was taught. This was supported by concepts like pairing of objects, counting, calculations, measurements (Allen, 2000), unit concepts and their plurality (Paul, 1994), numbers, logistics and techniques of computation (Dossey, 1992,) which already existed in this era, and are still known even today.

In India we noticed the notion of an ancient teacher, the Guru, who was much closer to what we currently have as a teacher (Rajput & Walia, 2001). The Guru had learners around him. Though it was not clearly stated what it was that the Guru was teaching, but he was in charge of the body of knowledge that he taught and he also monitored his learners' learning (Rajpu & Walia, 2001). The society entrusted him with everything. In this context, the Guru was an embodiment of all that had to do with his teachings (Bass, 2005). He was a one-teacher school as he was responsible for all the different levels of learners. He operated alone. So, this was the notion of a teacher that we found in India at the time.

The concept of *Ngaka* as observed is similar to that of Guru. The only difference is that with the *Ngaka* the teaching is linked to spiritual beings – the owners of the knowledge. The *Ngaka* is a teacher and a healer informed by the spirits. In the context of our day-to-day practices, he is the embodiment of a teacher (Bass, 2005). He is also responsible for the learners at different levels just like a Guru. To a greater extent, he is also a one-teacher school.

In this era, classic grounded theory allowed the literature to emerge theory (Elliot & Higgins, 2012) of the notion of a teacher as a person who was in charge of all the different aspects of teaching. Gillian et al. (2013) mentioned that the theory should be allowed to emerge. The curriculum, its delivery, and the assessment of learners were all the teacher's responsibilities. He was also responsible for all the learners at different levels of learning. Subject specialisations as mentioned by Rao and Vijay (2011) were almost non-existent. The only thing that was observed was a teacher who embodied all there was for learners to know (Bass, 2005), as the teachers in this era were the ones who had knowledge of what was to be taught to the learners (Davis, 1978). But, there was no mathematics teacher as is the case today.

4.3. Era 2 (1000 AD- 1900 AD)

4.3.1. Introduction

The history of the notion of a teacher again has been investigated in this era, trying to identify its evolution and modifications. The main focus has been to check whether mathematics was not taught to learners so that we can begin to trace the evolution of the notion of an embodiment of a mathematics teacher. Furthermore, the way in which the growth in mathematics has been continuing has been outlined to assist in tracing the growth in mathematics content. The information collected about the notion of a teacher has been further reflected, looking at how this teacher has been affected by the growth in mathematics, and also whether the notion we have in this era as a secondary mathematics teacher has been a suitable embodiment of a secondary mathematics teacher.

4.3.2. Findings

Dani (2012) proved in his study that Backshali manuscripts were there in the ancient Indian mathematics, and these manuscripts were found by a farmer in 1881, and the date of the manuscripts was estimated to be of around early millennium (1000 AD) to the 12^{th} century. In 1782, Clements and Ellerton (2010) found that in the US mathematics textbooks were mainly for teachers and not for learners and one textbook for learners which was there had been written by Benjamin Dearborne, and it consisted of only 16 pages. We further learned from Davis (1978) that in the year 1607 in England, teaching was observed when people with knowledge and wisdom on something gathered people around in family houses and taught them, since there were no formal buildings known as schools.

In addition, Clements and Ellerton (2010) noted that most school learners did not study mathematics in 1810, and for those who did, they only studied arithmetic and no algebra, geometry, or trigonometry were taught as most mathematics school teachers did not have qualifications in mathematics, and were therefore lacking knowledge to teach some of the contents in mathematics. Kunen (2007) spoke of permutations and algebraic equations which were established around 1800 and infinite sets in 1880s to 1890s by a mathematician called Cantor. Furthermore, German mathematician Gottlob Frege founded a school of logicism in 1884, which suggested that ideas of mathematics are to be viewed as subsets of ideas of logic (Dossey, 1992).

It should be considered that when schools, as known today, started in 1624 in London, they started with primaries only (Davis, 1978), and secondary schools followed around 1813 in India (Sharma, 2013), 1821 in Europe (Holsinger & Cowell, 2000) and 1825 in the United States of America (Brown, 1899). In Scotland, there were two types of schools, the Parish school (elementary secondary education) and the Burgh (true secondary), (Connor & Robertsons, 1990), but it was not stated clearly when the two schools were established. When primary schools were established, teachers were trained, but on the contrary, when secondary schools were established, teachers were not trained (Davis, 1978).

Conant (1892) mentioned that 40 to 50 years back, any person would teach mathematics, but now there seems to be a necessity to train mathematics teachers. Conant (1892) came with an outcry for formal training of mathematics teachers supported by Jacobs (1897) with a plea for specifically secondary mathematics teachers to be trained, and hence only came a few mathematics teachers who were trained around the year 1900. A study by Blair, Gamson, Thorne and Baker (2004) shows a graph which emphasises that just after 1890 there were a few people enrolled in schools.

In Britain, a man named Pestalozzi taught mathematics only at his school where he taught naming of numbers before introducing figures and notations (Connor & Robertson, 2000). He was one of the founders of mathematics schools. Another mathematician by the name of Felix Klein "embodied abundant qualities rarely seen in such harmonious combination in a single individual" (Bass, 2005, p. 419), and was also a "gifted teacher to mathematicians" (Bass, 2005, p. 423) and "shed the light of disciplinary mathematics" (Bass, 2005, p. 419).

4.3.3. Reflections on the notion of a mathematics teacher in era 2

This was an era where there was an emergence of a mathematics teacher. We found a mathematics teacher, named Pestalozzi, who had a school, and only taught mathematics in his school on naming of numbers before introducing figures and notations (Connor & Robertson, 2000). The mathematics that was taught was manageable as its contents fitted in a 16 pages textbook (Clements & Ellerton, 2010) unlike today where we have more than 300 pages long textbooks in secondary schools. Also there was a teacher named Felix Klein who shed light of mathematics to other mathematicians, and was regarded as a gifted mathematics teacher, and further embodied the subject (Bass, 2005). This was an era where mathematics started to be taught to leaners.

In this era mathematicians were no longer just pursuing the subject by coming up with a lot of discoveries in mathematics, but they also taught mathematics (Connor & Robertson, 2000). There was some form of sharing knowledge to others, although in my view the way they taught was more like how to become a mathematician by doing mathematics, and not on how mathematics can be important in your life. Most importantly, these mathematicians are still known today, not because of their teaching, but because of what they discovered; hence, even the mathematics content of today still constitutes of the works of Pythagorus (theorem of pythagorus), Euclid (axioms) and others.

When schools were established in 1624, as has been pointed out earlier, primary school teachers were trained (Davis, 1978). The training of primary teachers was in such a way that a teacher was regarded as a “know all” when trained, as he was supposed to teach all the subjects. This teacher was embodied with all that there was to teach a child in a school. He was regarded as an embodiment (Bass, 2005) of all the disciplines (nature, spatial, social, general etc.). This revealed that the training of primary schools was made to be similar to the way ancient teachers like Gurus were.

Around 1813, secondary schools were established (Sharma, 2013) but surprisingly, teachers were no longer trained and the untrained mathematicians were employed to teach in secondary schools. In mathematics, learners were only taught arithmetic; no algebra, geometry and trigonometry (Clements & Ellerton, 2010) was taught. It was found that mathematics content of the eras around 1813 had only basics like counting, calculations and measurements (Allen, 2000). There were no reasons stated why suddenly the secondary teachers were not given similar treatment with regard to training when their schools were established.

Not forgetting that the eras around 1800 were the eras of war which motivated mass productions, where people were fighting one another and wanted to outplace each other in terms of social and economic development. That was when industrialisation came through and hence the emergence of schools. Conant (1892) was one person who voiced out a plea for secondary mathematics teachers to be trained, supported by Jacobs (1897) and Hanus (1897) who also requested that all secondary mathematics teachers be trained. Towards the end of 1890, all mathematics teachers were trained. This led to the notion of who a mathematics teacher was supposed to be. Now wisdom and knowledge alone were no longer regarded to be enough for one to teach mathematics like Davis (1978) used to say. Training of mathematics teachers was also necessary (Conant, 1893) for one to teach mathematics like it is today. The thinking that a mathematician would teach mathematics was no longer viewed to be important. There was a great shift, where all teachers, whether primary or secondary, required training in order to teach learners. So this era, seemed to have aroused challenges which led to a review of a secondary mathematics teacher to be trained.

Looking at what was happening between 1624 and 1830, there was a lot of confusion as to who was supposed to be regarded as a mathematics teacher because secondary school teachers were not offered training like primary teachers. There were two types of mathematics teachers: trained mathematics teachers teaching primary school learners, and untrained mathematicians teaching in secondary schools. But, both of them served as the embodiment (Bass, 2005) of still a manageable mathematics because learners were only taught arithmetic, and further mathematics had contents that fitted in a 16 pages textbook (Clements & Ellerton, 2010). However, mathematics continued to grow as observed by Kunen (2007), who mentioned the establishment of permutations, algebraic equations and infinite sets around 1800. Theory emerged of a mathematics teacher of this era to be one who was still working with a manageable subject, and therefore a suitable embodiment of a mathematics teacher.

4.4. Era 3 (1901 – 2000)

4.4.1. Introduction

The notion of a secondary mathematics teacher has been investigated, following how it has been modified from era 2 to this era. The growth in mathematics contents has been observed to be continuing, and equally the emergence of mathematics education, which has been growing from the moment they arrived. Still there have been reflections on the notion of a secondary mathematics teacher of this era, tracing also how the growth in both mathematics content and mathematics education affected the notion of the embodiment of a secondary mathematics teacher. There have been traces of the modification on the notion of a teacher, and also a continuous comparison of this notion of an embodiment of a teacher to the expected notion of today. Finally the notion of an embodiment of a secondary mathematics teacher of this era has been identified.

4.4.2. Findings

It was found from Avigad (2007, p. 4) that the mathematics history of the 19^{th} century seemed to be the “birth of ‘modern’ style of mathematical thought that is practised today”. Blair et al. (2004, p. 99) indicated that “almost no mathematics was offered to the youngest students during the early 1900’s”. The above two studies both agreed that the mathematics that is being taught to learners today, started in the early 19^{th} centuries. It should be noted that when schools emerged around 1624 (Davis, 1978), mathematics was only taught to older students (Blair et al., 2004). So this was an era where the elementary grades were being introduced to mathematics, where they were taught a set of theories, operations and place values (Woodward, 2004).

Between 1940 and 1957, it was found by Woodward (2004) that the United States agreed to a surge for funding to produce more mathematics teachers who would assist their country to compete internationally. Equally important, Woodward (2004) pointed out that 1950s and 1960s were the golden ages in mathematics field of education because of more funding for research and training in mathematics. It should be noted that towards the end of era 2, there were pleas made for secondary mathematics teachers to be trained (Conant, 1893; Hanus, 1897; Jacobs, 1897), hence this era becomes an era where now all teachers, whether primary or secondary, training was required for one to teach. This was supported by Ahonen (1997) when he mentioned that around 1970s there was an establishment of training colleges for teachers.

However, Joshi, Limaye, Pai and Sharma (2007, p. 2) emphasised that mathematics department started with only two faculties in Mumbai in 1958, and in 1960 it grew and had “continuous stages of developments”, and even moved to its own campus; hence, Freudenthal (1968, p. 3) noted about the “activity of organising matter from reality or mathematical matter-which he called ‘mathematisation’” in 1968. Within two years of the establishment of mathematics education, it immediately grew to an extent of the need for re-establishment of its own campus, which was done as highlighted by Joshi et al. (2007).

Dexter (1906) came up with arrangement of mathematics curriculum and how it should be designed, and was supported by the establishment of the National Council of Mathematics Teachers in 1920 (Austin, 1921) which ensured that educators received the necessary support required to teach mathematics. Within a few years of mathematics teachers being trained, Sarton (1936) realised that the mathematics world was so large for a single mind to grasp. He was supported by Mack (1961) when he mentioned that unlike science where the new concepts removed the old ones, mathematics kept on adding new concepts to existing ones.

In addition, around 1990, Blair et al. (2004, p. 99) mentioned that teachers introduced types of challenging mathematics problems like “sophisticated geometry problems”, and Woodward (2004) focused on introducing 2 digits addition problems and negative number fractions. Blair et al. (2004) further continued in 2000 about reasoning tasks in recognition and completion of patterns. These further made additions to already existing mathematics contents (Mack, 1961). In 1997 there started to prevail issues of poor training of teachers at higher institutions, which seemed to be having an impact on poor performance of leaners in schools (Holton, 2001). Moreover, Desai (2012, p. 54) pointed out that “the teacher education centres and the curriculum followed in teacher education have very little focus on new trends in education”. Some authors came up with suggestions on how mathematics training and mathematics instructions should be, which would better improve learners’ performance in the subject. Hence we hear from Government of Ireland (1999) that if mathematics would be integrated with other subjects during instructions, and teachers would engage in continuing professional development (Askew et al., 1997), maybe the problems of underperformance faced in mathematics may be eradicated. In addition, Naik (2011) further spoke of the need to change and reform the teacher professional developments.

The year 1970 was referred to as back to basics in arithmetic and the beginning of standardised tests (Woodward, 2004). Back to basics according to Pejouhy (1990) was said to be only covering the lecturing, drilling and testing, which only catered for 5 to 15 percent of learners. In 1973, Freudenthal further expanded on his mathematisation of 1968 into horizontal and vertical mathematisation, where he spoke of organising mathematics tools, and solving problems daily, reorganisation and operations. As for Bishop, Clarkson and Presmeg (2008, p. 168), he emphasised that the “history of mathematics education research and practice [would] recognise the 80s as the era of the rise of the cultural dimensions of mathematics and mathematics education”. He was supported by Paul (1994) that in 1980 problem solving was the focus of mathematics in schools. Again, Von-Glaserfeld (1995) spoke of the radical constructivism in 1983 in Montreal. In today’s mathematics contents there are multiplication, division, fractions and problem solving (Da Ponte & Chapman, 2007), with an addition of numbers, measurement, geometry, data, algebra and functions, statistics, probability and many more (Neidorf, Binkley, Gattis & Nohara, 2006).

4.4.3. Reflections on the notion of a mathematics teacher in era 3

In this era, both primary and secondary mathematics teachers were trained, but there continued to be discoveries of new concepts in mathematics on a continuous basis, adding more to the existing ones (Mack, 1961). Bearing in mind that this growth was of great demand as Devlin (2008) pointed out, the growth in mathematics was due to new ways that were needed to solve problems, so there was no way this growth would have been stopped, but it made mathematics larger than one can imagine**.**

Again, the problem of untrained teachers was no longer an issue in this era as now it was well known that for anyone to become a teacher, training was necessary. But, as training would not have been done overnight, still in the beginning of this era many mathematics teachers were still untrained, but most importantly, that confusion of having two types of mathematics teachers, where primary ones were trained and secondary ones untrained, was under the process of being resolved. Now everybody agreed that mathematics teachers must be trained. No more wisdom and knowledge alone were enough (Davis, 1978) to allow one to be a secondary mathematics teacher, but to also have formal training (Hanus, 1897). Even funds were raised to ensure that teachers obtained formal training required to be teachers (Austin, 1921), which brought the emergence of mathematics education.

Ahonen (1997) mentioned that the establishment of teacher education training was around 1970s. On the other hand, now that teachers underwent training, there emerged mathematics education. Immediately after the emergence of mathematics education, it grew larger such proportions that it was even moved to its own campus (Joshi et al., 2007). Its growth was almost similar to that in mathematics content as noted by Sarton (1936) and Mack (1961) in era 1 and era 2. Similarly, in this era, studies noticed the growth in mathematics education (Joshi et al., 2007), and further the growth in mathematics content never ceased (Mack, 1961). Both mathematics content and mathematics education were continuing to grow in this era, hence each era since era 1, there were complaints about this growth (Sarton, 1936; Mack, 1961).

The notion of an embodiment of a secondary mathematics teacher of this era was now faced with a very large and complex subject (Mack, 1961). Mathematics had moved to being packaged in a 16 pages textbook (Clements & Ellerton, 2010) to now more than 300 pages in secondary mathematics textbook. What about the notion of an embodiment of a secondary mathematics teacher who was supposed to teach this large mathematics? The requirement of this embodiment of a secondary mathematics teacher has increased and so has the subject content.

Furthermore, there were two types of mathematics teachers, one at the primary school level being trained, but unspecialised in mathematics (Education and Culture, 2011) and taught a number of disciplines. The secondary teacher, on the other hand, was trained and specialised (Rao & Vijay, 2011) in mathematics. With primary teachers, a teacher was trained to teach everything, following the concept of a Guru (Rajput & Walia, 2001), but in secondary schools, teachers were trained differently where they had to specialise in a particular discipline. Hence, two kinds of mathematics teachers were in existence.

A number of challenges arose in mathematics. Issues of poor teacher training led to learners' underperformance in some subjects, and mathematics was one of the subjects which was underperforming and became a great concern (Holton, 2001). Furthermore, teacher training was not aligned with the changes of the curriculum in schools as they are non-changing (Desai, 2012). Many suggestions were raised on how best to train teachers, how teachers can teach better, how best learners can learn etc., but still learners underperformed in mathematics.

Sometimes one wonders what seems to be wrong with South African mathematics. Initially some contents were there, later they were removed and modern mathematics was introduced, thereafter back to basics (Woodward, 2004) which also never worked for us. It seems even the country as a whole was not quite sure of what must fit in the subject mathematics. In my opinion, this confusion was brought by the growth in the subject since it is complex and confusing. Around 1970s to 1980s studies started to question whether an individual person was enough to grasp all there was to know in mathematics (Mack, 1961). In South Africa we have done away with arithmetic and focused on mathematics alone, later introducing MMLMS (Mathematics, Mathematical literacy and Mathematical Sciences), and later further removed MLMMS and classify Mathematics and Mathematical Literacy separately. This shows that we are also not so sure of what this mathematics is, or what it requires.

In my view, all this confusion that we have does in a way alert us to acknowledge the fact that we are also recognising the complexity of the subject and saying it is not one thing. By this I am trying to compare my own views to what was found from the literature (Glaser, 1992; Elliot & Higgins, 2012), and also to the theory emerging (Glaser, 1998). It is possible and very common for a trained mathematics teacher to be strong in the knowledge of some concepts in mathematics, and weak in others, which make me to agree with Karigi and Wario (2015) that as a country we have not yet found the real problem that causes underperformance in mathematics. This should raise questions of whether mathematics would ever be possible to be a known and understood subject as a whole to an individual, with all it entails. Classic grounded theory allowed theory to emerge (Elliot & Higgins, 2012) with the notion of a secondary mathematics teacher being challenged and unable to effectively teach mathematics of this era as it was growing larger than expected.

4.5. Era 4 (2001 - 2015)

4.5.1. Introduction

In this era, there have been more studies that also identified mathematics to be growing so large and further becoming confusing. Again, there have been a number of challenges that have been outlined. There have not been many discoveries encountered in mathematics in this era, but a lot of challenges have been identified with regard to a mathematics teacher, including the possible solutions towards solving these challenges. There have been reflections done on the findings regarding the challenges found, which have been assisting towards finding the suitable notion of the embodiment of a secondary mathematics teacher of this era.

4.5.2. Findings

In this era, we realised that Krantz (2010, p. 3) was also complaining that "today mathematics is a large and complex enterprise…those of us who choose to study the subject can only choose a piece of it". Most recently, also Ellerton (2014) compared mathematics to a growing tree. It seemed everybody had now realised the complexity of mathematics. It should also not be forgotten that the system of primary teacher training and that of secondary teacher training were still different; the training of a primary teacher embraced all the disciplines, and that of a secondary teacher allowed one to specialise in a chosen discipline. Hence, Education and Culture (2011, p. 12) named the qualification for primary teacher training a "compulsory minimal level" where a teacher was compelled to study all the disciplines required in a primary school. The secondary teachers' training provided teachers with "different pedagogical specialisation" (Rao & Vijay, 2011, p. 5), where teachers specialised in a certain discipline. On the other hand, Schleicher (2007, p. 13) also conducted a study where low performing primary teachers were allocated learners to teach for a longer period, and it was revealed that those learners also performed poorly and created "an educational loss which is largely irreversible".

There were a number of challenges encountered with regard to mathematics, which some might have been brought by the growth in the subject (Krantz, 2010). We learnt that South Africa was placed at position 137 of 139 countries in mathematics and science education, which was due to poor teacher education and the poor state of subject content knowledge by teachers (Cohen & Seria, 2008). Chisholm (2008) added that it was important for teachers to have an in-depth knowledge and thorough understanding of the content they were teaching, but of more importance, the ability to pass the knowledge in a meaningful way to learners. The problem of lack of content knowledge still reappeared even after teachers enrolled for higher education to upgrade their knowledge, which showed that even higher education did not assist teachers by providing them with better teaching capabilities (Sheperd, 2013). Ali (2011, p. 60) mentioned that teachers do not have "command over subject matter knowledge in mathematics". On the other hand, Global Campaign for Education (2012, p. 13) emphasised that the "teacher skills and competencies are acquired through high quality teacher training", which seemed not to be the case in South Africa. Deshler et al. (2015, p. 639) mentioned that "what instructors do in the classroom makes a difference in the learning opportunities students have". The teacher can only make a difference to the education of the children only if s/he has an in-depth content knowledge of the subject s/he is teaching.

Wilson, Cooney and Stinson (2003), Ingvarson, Beavis, Bishop, Peck and Elsworth (2004), Magiera, Smith, Zigmond and Gebauer (2005), Lim (2007), Hunt (2009), William (2011), Popoola and Odili (2011), Cushman (2004) and Portman and Richardson (2012) all had one thing in common when they spoke about co-teaching. They found that if teachers would work together as a team, they would then achieve better results in mathematics. For some authors like SRI International (2007), Anthony and Walshaw (2007) and Nash, Jonkin and Van Zyl (2012), they thought maybe the challenges in mathematics would be over if technology was integrated into the teaching of mathematics. I believe all the above-mentioned authors also acknowledged the fact that an individual notion called a secondary mathematics teacher needed to be complemented with something in order to be able to facilitate the subject effectively.

On the other hand Teo and Milutinovic (2015) noticed that teachers had negative attitudes towards computers, and their attitudes led to poor implementation of technology in the mathematics classroom. It was found that the use of computers would assist in the teaching of mathematics, but teachers are having bad attitudes towards technology, therefore challenges in mathematics are not nearing the end. Government of Ireland (1999) and Cai et al. (2009) emphasised integration of mathematics with other subjects, which to them would make mathematics easily understood. Naik (2011) also complained of lack of professional development of teachers, which had become a serious problem in India, where he also asked a question of what it meant for one to be a professional.

4.5.3. Reflections on the notion of a mathematics teacher in era 4

Era 4 happened to be the one where many things happened, like manufacturing of war machines, man landing on the moon etc. Further the demand for technology was so large. There were no longer studies found on the discoveries done in mathematics, but issues about the history of mathematics education. Mathematics was now having its own philosophy and its own curricula, added to its history.

There were no longer mathematicians who served as mathematics teachers like it had been in the other eras, only trained and specialised secondary mathematics teachers (Rao & Vijay, 2011) and trained “know all” primary mathematics teachers were teaching (Education and Culture, 2011). The reasons why the two training camps were so different were not supplied. Since this study was focusing on the notion of the secondary mathematics teacher, most information regarding the primary teachers was only used to highlight some of the important ideas, and was therefore not thoroughly investigated, but the issue of different training types also had a lot of implications to the underperformance of learners in mathematics. Hence we also learned from Schleicher (2007) that incompetent teachers produced incompetent learners.

Moreover, there were a number of challenges encountered in this era with regard to the teaching and the learning of mathematics. There were issues regarding poor training of teachers (Ali, 2011) which failed to provide teachers with skills and competencies required to teach (Global Campaign for Education, 2012). Surely, other problems towards underperformance in mathematics were caused by the way in which mathematics teachers were trained.

A number of authors believed that understanding of content knowledge by the teacher would reduce the challenges of poor performance in mathematics (The Education Alliance, 2006; Pejouhy, 1990; Anthony & Walshaw, 2007; Adams, 2012; Ekmeckci et al., 2015). Others mentioned co-teaching (Lim, 2007; Hill et al., 2014), professional development (Deshler et al., 2015; Dreher et al., 2015) and integration of mathematics with other learning areas (Victoria University, 2008) or with technology (Moursund & Albrecht, 2011; Pia, 2015; Swee, 2015; Teo & Milutinovic, 2015). But still, underperformance in mathematics is a challenging factor. So the problem might be what we regard as an embodiment of a secondary mathematics teacher of this era. The embodiment of a secondary mathematics teacher of this era has been faced with a number of challenges which prevented him or her with the right to exercise his or her duties in a satisfactory manner. One major challenge has been the growth of the subject. It is just too large (Krantz, 2010; Ellerton, 2014) than one can imagine, and therefore an individual has no capacity to grasp all there is to know in mathematics. A lot of studies agreed that something needed to be done to mathematics because it is indeed a challenge. This showed a common understanding that we all acknowledge the fact that the current notion we have of a secondary mathematics teacher cannot embody the expected secondary mathematics teacher, which is what Festinger (1962) termed cognitive dissonance, whereby the experience of a researcher, and the little knowledge s/he has, emerges as a theory through the literature.

4.6. Conclusion

This chapter outlined the findings collected with regard to the notion of an embodiment of a secondary mathematics teacher of different eras. Further, there have been reflections done to what emerged to be a notion of an embodiment of secondary mathematics teacher of each era, compared to what is expected today as a suitable embodiment of a secondary mathematics teacher. The first and second eras have shown the teacher who was an embodiment of the subject (Bass, 2005) as he was able to manage the subject and all there was to teach the children (Davis, 1978). As we moved to era 3 and era 4, there have been a number of challenges which were so impossible for a teacher as an individual to teach mathematics effectively. Mathematics contents and mathematics education have both been growing horizontally and vertically, which made an embodiment of a secondary mathematics teacher to no longer be a suitable notion. This revealed the need for a new notion of a suitable embodiment of a secondary mathematics teacher, one who is able to manage the subject.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

In this chapter, the conclusion focuses on issues found from data in all eras regarding a teacher. Drawing from the four eras that have been investigated, I have organised the conclusion guided by the research question posed, which was supported by substantive theory (Elliot & Higgins, 2012). The research sub-questions have been answered, and their answers led to the answer of the main question. Taking into consideration that this problem of an embodiment of a secondary mathematics teacher cannot be resolved instantly, therefore answers to the research question cannot be regarded as solutions to the problem, but rather suggestions. There has been a continuous reflection to trace whether the notion of a teacher in each era has continued being a suitable embodiment of what is expected from as a secondary mathematics teacher today. Headings of this chapter have been the sub-questions, with the main question being the last heading. The sub-questions served as categories that have been developed (Elliot & Higgins, 2012). Today's notion of a secondary mathematics teacher is located and further investigated as to whether this notion is a suitable embodiment of a secondary mathematics teacher which is currently required. Recommendations have also been done which would serve as possible solutions to the problems encountered with the current notion of an embodiment of a secondary mathematics teacher. There is also the limitation to the study and ending the chapter with the concluding remarks.

5.2. Conclusion

5.2.1. How the notion of a mathematics teacher changed over time

In era 1, there was not much found about the notion of a teacher as known today. But there were teachers from Greece known as Livius Andronicus (Connor & Robertson, 1990) and a Guru in India (Rajput & Walia, 2001) who were the embodiments of all there was to teach learners, just like Felix Klein who served as somebody who shed light in mathematics, a gifted teacher and an embodiment of mathematics (Bass, 2005). Whilst Guru and Livius Andronicus were responsible for a wide ranging knowledge (wisdom), Felix Klein was a specialised practitioner who taught mathematics (Bass, 2005). The general notion of a teacher for this era is somebody with the requisite wisdom to share with learners who mainly stayed with the teacher. The teacher was a custodian of knowledge and how it is packaged and shared.

In era 2, there was a mathematics teacher by the name of Pestalozzi who only taught mathematics (naming of numbers, figures and notations) in his school (Connor & Robertson, 2000). In this 1, as was the case in era 1, the teachers who were there had no formal training to become teachers. It was believed that skills and knowledge on something would make one a teacher (Davis, 1978). It was not until much later that authors like Conant (1892) complained of untrained teachers who taught mathematics. There seemed to be a problem identified with learners being taught by untrained teachers. The notion of a teacher was modified to a state where a teacher's knowledge and wisdom on something were no longer considered to be enough to teach (Davis, 1978) as formal training become necessary (Hanus, 1897; Jacobs, 1897). That is, whilst the teacher's mandate remained broad, it was essential that they received training.

In era 3 the training of teachers was regarded as essential, especially with regard to primary schools. Subject specialisation was downplayed as class teachers were seen as essential instead of subjects. This is in line with the system of the Indian Guru (Rajput & Walia, 2001), where a teacher was supposed to teach all the subjects (Education and Culture, 2011). The only difference was that this time a child would be with this "Guru" in grade R, then move to another "Guru" in grade 1, and so forth, unlike with the Indian Guru as he served as a one-school teacher. The training of teachers served as the initial stage of modifying a teacher from being untrained mathematician to being required to train before they could teach. The notion of a mathematics teacher was no longer just anybody with skills and knowledge on mathematics (Davis, 1978), but someone having trained to teach everything in a primary school (Education and Culture, 2011).

Surprisingly, when secondary schools were established in 1813 in India (Sharma, 2013), 1821 in Europe (Holsinger & Cowell, 2000), and 1825 in the United States of America (Brown, 1899), teachers were no longer trained (Davis, 1978). Thanks to men like Conant (1892), Jacobs (1897) and Hanus (1897) who ensured that secondary teachers were later trained. This was the second modification on the notion of a teacher, moving from a state of not only being trained, but also specialisation (Rao & Vijay, 2011) in a chosen discipline, because that is the way in which secondary teacher training happens even today. I believe the reason for training a secondary school teacher differently from that of a primary school meant that there was something that was not pleasing with a teacher being trained to teach all the subjects (Education and Culture, 2011) and hence a secondary teacher training was taught differently. I also thought maybe primary teachers training would be reviewed and made similar to that of secondary schools, but that was not the case. I then fail to understand why secondary teachers' training was not treated the same as that of primary schools. It would have been better if primary teachers' training followed the pattern of secondary teachers' training. Primary school teacher training was left to be such that a teacher was still regarded as someone knowing everything, and was supposed to teach all the disciplines. In era 4, it was found that the same teachers who were in era 3 were still there, and primary teachers were trained to teach everything (Education and Culture, 2011) there was for learners to know, and secondary ones specialised in mathematics (Rao & Vijay, 2011).

Teachers like Pestalozzi who taught naming of numbers, figures and notations (Connor & Robertson, 2000) and the Guru (Rajput & Walia, 2001) were the embodiment of all the knowledge they taught (Bass, 2005). They were the ones who came up with what was supposed to be taught to the learners, decided how to assess the learner, and also came up with ways to progress the learners. This is different from today where the curricula, the assessments and progression requirements are decided by somebody or an office out there, and the teacher is supposed to implement.

All the traces on the notion of a teacher emphasised in the paragraphs above show how the notion of a teacher has changed over time. Initially we observed a general teacher responsible for learners with different ages, followed by a teacher for specific ages or classroom teachers, and subject teachers emerged later on. That is, the notion of a teacher was differentiated vertically according to classes and later horizontally according to subjects. For example, there are Grade 1, Grade 2 and

Grade 3 teachers and mathematics, science and history teachers. The notion of a teacher was narrowed from its earlier forms as knowledge and skills required to teach became complex.

5.2.2. How mathematics has been growing over time

The birth of mathematics cannot be clearly verified. Sarton (1936) claimed that mathematics was there in the fifth centuries BC as it had been exercising people's minds even before science. On the other hand, Paul (1994) believed mathematics started around 3000BC, whereas Dossey (1992) said its origin was in the 4th century. If mathematics has been exercising human's minds, then mathematics originated since the beginning of life.

There were a number of mathematicians who pursued the subject as individuals like Aristotle (who came up with theory of numbers, logistics and techniques of computation) and Eudemus (Rouse Ball, 2010), Pythagorus (Joseph, 2011), Livius Andronicus (Connor & Robertson, 1990), Euclid (Kunen, 2007), Gemius (who came up with methods of proofs in geometry) (Rouse Ball, 2010) and many more, as there were no buildings known as schools. This emphasised the beginning of the growth in mathematics content. Mathematics content started growing even before it was taught because these mathematicians were only there initially pursuing discoveries in the subject, and not teaching it. So, as a matter of fact, mathematics started growing even in the BC eras because these mathematicians pursued the subject in those eras.

The growth in mathematics content was also emphasised when some authors said mathematics world has outgrown an individual being (Sarton, 1936; Mack, 1961; Krantz, 2010; Ellerton, 2014). Sarton (1936) was the first man to realise that mathematics world has grown large for a single mind to grasp. Ever since Sarton's discovery on the growth in mathematics in 1936, the growth never stopped. In each and every era there was an author complaining about this growth (Mack, 1961; Krantz, 2010; Ellerton, 2014), but then one wonders, what was done with regard to the notion of a teacher after realising the growth in the subject the teacher was supposed to teach? It seems nothing was done. A primary school teacher was left to continue being trained with all disciplines in one (Education and Culture, 2011).

If mathematics alone has grown this large, what about other disciplines like sciences? If these growing disciplines are all placed in a single group, and each of them keeps on growing, it would definitely be a challenge for an individual primary school teacher to manage all of them. It seems we have forgotten the impacts this growth would have on a teacher. What we had in era 1, whereby a teacher was an embodiment of all there was to teach a child (Bass, 2005), can no longer be a suitable notion to embody the subject even today after it has grown extensively. On the other hand, Ali (2011) pointed out the issue of secondary learners' underperformance in mathematics being due to lack of quality intervention at the primary level. Primary school teachers are unable to provide quality teaching in mathematics since they have been uploaded with a heavy task of teaching all subjects, which keep on growing larger.

Looking at a secondary mathematics teacher, even if s/he was trained to specialise in mathematics (Rao & Vijay, 2011) and maybe one other subject, which is far much better compared to a primary teacher, still mathematics alone is growing so large (Sarton, 1936; Mack, 1961; Krantz, 2010; Ellerton; 2014). Such teachers should not have other teaching responsibilities. Let us not forget that other subjects like science are certainly growing the way mathematics is. Today's mathematics teacher cannot be treated the same way as the ancient Gurus (Rajput & Walia, 2001), who had all there was to teach a child. Mathematics of the then era was manageable. Primary teachers might have been managing in the past with a number of subjects, but that cannot be the case today. As for secondary mathematics teachers, mathematics had a 16 pages long textbook (Clements & Ellerton, 2010) in the past, what about today? Duval (2000) said mathematics covers a broad and various range of contents from primary schools to university. That is why the study was basically investigating what or who would be a better notion to embody a secondary mathematics teacher of today, because what we currently have is totally not suitable.

If today's mathematics was to be regarded as a loaf of bread, a person can only study a slice of it, which was more similar to what Krantz (2010) said when he mentioned that one can only study a piece of it. What is supposed to be done about this growth in mathematics? We are nearing a century since the problem of mathematics having outgrown an individual mind was identified (Sarton, 1936), which in my understanding this growth existed even before 1936. The growth in mathematics started immediately after it was discovered. Is it not time for us to review the challenges in this subject in relation to what we expect a teacher to teach? It is indeed tough for an individual to grasp all the necessary skills, values, knowledge and attitudes required in mathematics (Sarton, 1936) for one to be able to pass these skills to learners in a satisfied way, considering mostly the way in which mathematics keeps on growing (Ellerton, 2014). Mathematics content and mathematics education have been growing exponentially, leaving the notion of a teacher behind, and they would further continue to grow (McLennan, 2009). All the challenges faced in mathematics are caused by a belief that an individual notion of a secondary mathematics teacher has been regarded as a suitable embodiment even after the subject continued to grow, comparing this notion to the ancient Guru (Rajput & Walia, 2001) and Felix Klein (Bass, 2005). This notion is not compatible with the modern world and modern ideas and concepts regarding teaching mathematics. It is time that we acknowledge the fact that the growth in mathematics has indeed affected the notion of an embodiment of a secondary mathematics teacher. Vertical and horizontal differentiation of the notion of a teacher as discussed earlier were found to be a solution when general knowledge was found to be too cumbersome. Class teachers in primary schools and subject teachers in secondary schools should focus on specific roles of a teacher.

5.2.3. The qualities that are supposed to be revealed by today's mathematics teacher

Currently, studies keep on emphasising that the qualities of an effective mathematics teacher are observed when teachers work as a team (Lim, 2007; William, 2011; Popoola & Odili 2011; Hill et al., 2014), which according to Global Campaign for Education (2012) enable production of better results in some countries. These studies are in a way also saying something is wrong with the notion of an individual teacher being entrusted with the responsibility of being a suitable embodiment of a mathematics teacher. Some authors speak of the ability of a teacher to integrate mathematics with technology (Moursund & Albrecht, 2011; Pia, 2015; Swee, 2015; Teo & Milutinovic, 2015) or the ability of a teacher to make mathematics be real in real life situations that are suitable for environment learners to find themselves (Victoria University, 2008; Murray, 2011; Pia, 2015). The above authors also acknowledge a similar aspect that an individual secondary mathematics teacher is overloaded with other larger responsibilities. Such a teacher cannot teach mathematics effectively.

Again, a mathematics teacher has been expected to have an in-depth content knowledge in mathematics (The Education Alliance, 2006; Pejouhy, 1990; Anthony & Walshaw, 2007; Adams, 2012; Ekmeckci et al., 2015) for teaching (Kaino, 2015). Schoenfeld (2012) mentioned that the teachers' success or failure is determined by the knowledge he has. Again, teachers seemed to be relying mostly on learners' textbooks (Jung et al., 2015). Relying on learners' textbooks would be due to lack of content knowledge on the part of teachers. Teachers only read from a textbook and explain what is contained in the textbook to learners. Teachers are unable to contextualise what they find in the textbook to what learners already know (Civil, 2008). On the contrary, the way teachers were trained seems to be unaligned with what they are faced with in schools (Major & Tiro, 2012), which is one of the problems teachers find themselves in: of not been trained properly but expected to implement quality teaching.

So, we do expect the notion of a teacher as an individual to have all these numerous qualities and abilities to be able to effectively teach the learners mathematics. But the question remains, is it possible for an individual to have all the qualities and capabilities mentioned above? On the other hand, we are also expecting an individual to be equally perfect in all these numerous concepts in mathematics, which cannot be the case. Definitely one may be perfect in one or two concepts, but not in all. Hence I still posit my argument that we have arrived at a point where we need to review the notion of an embodiment of a secondary mathematics teacher. Perhaps it is time secondary mathematics is split into pieces as Krantz (2010) suggests that an individual can study a piece of mathematics, not a whole of it, because that would be the only way to make mathematics manageable to an individual. There has been a need for teachers to specialise (Rao & Vijay, 2011), to do some parts of mathematics, not the whole subject. Until such time that secondary mathematics is split into portions that can be managed by an individual, underperformance cannot be resolved. If mathematics is split into pieces, then what we call today as a notion of a secondary mathematics teacher may qualify to be formed by a number of secondary mathematics teachers who have specialised (Rao & Vijay, 2011) in various parts of mathematics.

5.2.4. The type of notion that can embody today's secondary mathematics teacher

In the preceding sections I demonstrated that the current notion of a secondary mathematics teacher is inadequate, overgrown, and falls short in addressing the ever-growing problem of finding an ideal secondary mathematics teacher. Irrespective of our intentions to eradicate the challenges faced with regard to underperformance in secondary mathematics, not much is being achieved. Studies after studies (Holton, 2001; Strawhecker, 2005; Schoenfeld, 2012; Major & Tiro, 2012; Karigi & Wario, 2015) continue to show gaps in sustaining the resolution of mathematics teaching and learning. If a sound solution is to be found, then we need to review the embodiment of this complex notion of a secondary mathematics teacher. The notion of an individual as an embodiment of a secondary mathematics teacher is no longer suitable.

Instead of solving the problem that mathematics teachers are faced with, of not being able to effectively teach this gigantic subject, we keep on suggesting that teachers do not know what they are doing, that they lack adequate content knowledge (The Education Alliance, 2006; Pejouhy, 1990; Anthony & Walshaw, 2007; Adams, 2012; Ekmeckci et al., 2015) and do not have confidence (Moodley, 2014) in teaching mathematics. At this stage we have never asked the question as to whether it is possible to implement all that the researchers recommend in the context of the current notion of a secondary mathematics teacher. When the notion of class teachers became cumbersome, subject teachers become necessary. Now the notion of subject teachers has become cumbersome. That is, finer horizontal and vertical articulation and differentiation of the notion of a secondary mathematics teacher is now needed. A composite secondary mathematics teacher seems more desirable as an embodiment of a secondary mathematics teacher than an individual. This is not Wenger's (2011) concept of community of practice, or Murawski and Swanson's (2001) co-teaching. Ours is the re-conceptualisation of a secondary mathematics teacher, not his or her practices.

In the finer refinement of the notion of a secondary mathematics teacher, we have acknowledged the shift in vertical articulation as encouraged in the current policy in the training of mathematics teachers in South Africa. What initially was known as secondary schools now have two different phases: Senior Phase and Further Education and Training Phases. Each of these phases has its own teacher qualification. That is, an attempt is being made to formalise vertical differentiation of a secondary mathematics teacher. Our argument at this stage is that this should be accompanied by horizontal differentiation where mathematics splits into finer categories. As to the number of the splits, that will need further and more elaborated interactions between mathematicians, mathematics educators and policy developers. The purpose of this study remains that of placing the idea on the table.

5.3. Recommendations

Various countries are not presenting exactly the same topics in secondary mathematics, but do select some topics for their preferences because they cannot cover all the topics that are there in mathematics. But then should we say one country can cover this in mathematics and the other covers that? That is an indication that there is a problem since we cannot cover the whole of mathematics, and we are therefore reconceptualising and refocusing the teacher. I therefore recommend workable partitions of mathematics.

Another recommendation would be that the current notions of secondary mathematics teachers be in a position to work as a team of three or four teachers to teach one grade, where each takes an area or a topic which s/he is mostly competent in and also has confidence in teaching such a topic in the presence of the other colleagues. This should be done whereby educators themselves should be able to identify their challenging topics in each grade, or the topics which their learners fail to perform well even after they have taught such topics.

If the above two recommendations are adopted, this would also lead to a question of what is meant by training and placement of teachers. Such will lobby future questions. Should we then say schools must select preferable topics in mathematics or what will then be suitable for South African in relation to the teaching and learning of mathematics? Or should nations choose specific areas in line with their needs? All these questions would be ideas that may be embraced when we try to come up with possible solutions to the problem of an embodiment of a teacher in general.

It is recommended that other studies should be undertaken to determine as to how many individuals can constitute a composite suitable to embody the requirements of an ideal secondary mathematics teacher. Also other methods of data collections except documentary analysis are recommended in the same study.

5.4. Limitations of the study

This study was limited only to the use of documents for data collection. The use of interview of secondary mathematics teacher on the notion of an embodiment of a secondary mathematics teacher may also be of assistance in getting the suitable notion of an embodiment of a secondary mathematics teacher.

5.5. Concluding remarks

In conclusion, I would like to underline a few points. First is the importance for us as a country to identify the secondary mathematics topics that are relevant to our learners. This would make secondary mathematics manageable unlike it is now with contents that cannot be embodied in an individual.

Secondly, the need to review the higher institutions programmes for secondary educators to deal with more of the contents that they will be teaching the learners in schools. Also, there is a need for higher institutions to design programmes that will allow teachers to study workable partitions in mathematics. For an example, a number of teachers can be trained on different topics in mathematics and together as a group come and form a team to teach secondary mathematics. Such interventions can lead to us having what today's secondary mathematics teacher require. The team will then become a suitable notion of an embodiment of a secondary mathematics teacher, not an individual.

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