

Exploring the views of mathematics teachers on content excluded in the national curriculum

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Abstract

The purpose of this paper was to answer the following questions: What are South African mathematics teachers' perceptions on the exclusion of certain mathematics concepts in the national curriculum? Are the teachers interested in attending a conference presentation covering concepts that are not part of the mathematics curriculum? Answers to these questions were sought from mathematics teachers attending an annual conference organised by their association. Matrix transformation is the topic that was excluded from the national curriculum and when the two questions were asked teachers had various opinions. Given the utility of matrices in other mathematical areas such as transformation geometry, solution of linear simultaneous equations involving up to n -unknowns and other applications in Calculus it was thought that the topic will find space in the South African national curriculum. Given this background, teachers were keen to learn the content of the topic so that they are not caught unaware should it eventually be included. Implications of teachers' interest to learn new content are discussed in the paper.

Introduction

The choice on what subjects and content to include or not to include in a national curriculum is a daunting task for planners. The task is daunting because different stakeholders can put a lot of pressure for their preferred subjects and content and yet schools may have limited time to cover the prescribed content. Supposedly if schools had unlimited time to cover curriculum content then it would include all the concerns of stakeholders in society. In such a case the content selected and taught in schools would be suggested by parents, academics, the government, the business community, religious institutions, and non-governmental organisations among others (Mulyono, 2009). Unfortunately this is not the case because there are too many subjects that compete for time in the school curriculum, thus rendering each discipline limited time for instruction. Due to the competitive nature of subjects and content in the school curriculum, a democratic process of curriculum planning receives surmountable pressure on what to teach, to what depth and breadth. When too many subjects and topics are included in a curriculum what is covered in such curricula in reality could be superficial resulting in lack of understanding of what is covered. In such a case the curriculum can be described as 'a mile wide and an inch deep'. A suitable curriculum is one that provides learners with a balanced depth and width of content covered so that learners are able to make connections between

disciplinary content, apply concepts learnt in the classroom to solve problems encountered in society and to transfer knowledge gained in a discipline to personal conduct that shows signs of responsible citizenry. The scope of such a curriculum provides both cognitive and affective skills through broad and deep content in all topics included, learning experiences offered and organisational threads found in the curriculum plan (Goodland & Zhixin Su, 1992).

Due to the competing time by subjects on the school curriculum and the national priority given to different subjects there are two categories of curricula that exist, namely, core and non-core. For instance, the Korean mathematics learning has two periods of Compulsory Period the first 10 years of formal learning, Grade 1 to 10, and an Elective Period during the last two years, Grade 11 to 12 (Paik, 2004). The core curriculum includes a uniform body of knowledge that all learners should know and a predetermined body of skills, knowledge, and abilities that is taught to all students. In most parts of the world mathematics is a core-subject in national curricula up to middle secondary school. Mathematics has gained a core status in the school curriculum because it is considered to be a critical filter for entry into various career options and some people believe that the subject is a decisive factor for insuring the success of school leavers in any kind of future entrance examination in various fields (Brumbaugh & Rock, 2001; Paik, 2004). Due to these perceptions most students are expected by both parents and teachers to achieve highly in mathematics at school level (Paik, 2004).

Mathematics is assumed to train students to acquire logical reasoning skills, which could be applied in other career options. Due to the importance attached to the subject by society, the selection of content to include in a mathematics curriculum is one of the most critical decisions that educational planners make in order to come up with a comprehensive and inclusive document which appeals to most stakeholders. The choice of content as well as depth and breadth is important in the mathematics curriculum because most teachers rely on a curriculum document as their primary tool for teaching mathematical topics (Grouws, Smith & Sztajn, 2004). If a topic is not included in the curriculum materials that the teachers use, there is a good reason for them not to cover it in their instruction and learners will not learn it.

The basis of the present paper is on investigating the perceptions of South African mathematics teachers on content that is excluded in the national curriculum. The study was guided by the following research questions: What are South African mathematics teachers' perceptions on the exclusion of certain mathematics concepts in the national curriculum? Are the teachers interested in attending a conference presentation covering concepts that are not part of the mathematics curriculum? Answers to the research questions can provide insight to South African and mathematics teachers from other countries of their preparedness to embrace a curriculum that introduces new concepts.

Theoretical background

The dominant concern of any national curriculum is that of content or subject matter to be taught by teachers and learned by students (Lunenburg, 2011). Thus, selecting the content to include in a national curriculum together with accompanying learning experiences is one of the central decisions in curriculum planning. In emphasising the symbiotic relationship between content and learning experiences, Ornstein and Hunkins (1998) dubbed content as the “meat” of the curriculum plan, and learning experiences the “heart” of the plan. A rational method of selecting content and learning experiences to include in a curriculum is a matter of great concern so that adequate content and experiences are included. When the disciplines and learning experiences are defined in a national curriculum, then the syllabus in the United Kingdom (UK), standards in the United States of America (USA), curriculum or curriculum statement South Africa (SA) that indicate what content teachers should teach and learning experiences to be constructed for students is made available for implementation. Whilst the selection criteria of content to include in a curriculum is a delicate one, central issues to consider are focussed on a program that offers students developmentally appropriate content that is interesting, and relevant to their lives. Such learning experiences should emphasize student understanding through reasoning, inquiry, problem solving and also allow connections with other school subjects and life experiences at large (Hussain, 2009).

In the light of connections with other disciplines, for instance, one of the principles in the Mathematics National curriculum statement in South Africa is integration and applied competence. This integration is achieved within and across subjects and fields of learning. The integration of knowledge and skills across subjects and terrains of practice is crucial for achieving applied competence which aims at integrating three discrete competences – namely, practical, foundational and reflective competences. By adopting integration and applied competence, the National Curriculum Statement Grades 10 – 12 (General) seek to promote an integrated learning of theory, practice and reflection (Department of Education, 2003). Other considerations include the need to include fascinating and meaningful mathematical experiences, development of mathematical concepts aligned to the technological development of a country; facilitate the continued studying of mathematics at higher levels and making students become mathematically literate members of their societies. The depth and width of covering selected content depends on the level of formal education, namely primary, middle secondary and high school. Each of these levels is briefly explained below.

Generally there are common trends on the content and experiences that are emphasised in the primary school with a national goal of producing numerate citizens. At primary school level there is considerable agreement on those content areas of mathematics which should comprise the curriculum (Ruddock, 1998). The broad common content areas covered at the

primary school level are numbers, geometry and measurement (DoE, 2003). The learning experiences of these generic areas is to develop skills of applying mathematical concepts during problem-solving, communicating and expressing mathematical knowledge during discussion, integrating and connecting mathematical concepts to various areas that students encounter at school and in society. Furthermore, to develop reasoning skills to make deductive and inductive conclusions, understanding and recalling basic mathematical procedures in order to operate as numerate citizens.

At secondary school level there is likely to be considerable differences between systems in different countries. A preferred system of a country determines the balance between mathematical content areas and the degree to which particular aspects of mathematics are stressed. The level of compulsory mathematics education at secondary school also varies from one country to another. For instance, most European countries, Japan and Singapore have a compulsory national curriculum for mathematics up to middle secondary school (year 16). Passing mathematics at this level is assumed to open up equal job opportunities for all citizens as entry into most careers requires a mathematics pass. There is a plethora of mathematical concepts that students can learn at this level, so it is necessary to make careful decisions on what students should learn. These decisions need to be revisited from time to time as the totality of mathematical knowledge continues to grow and new demands for the subject change (Hussain, 2009). Given this background, Ornstein and Hunkins (1998) proposed four critical criteria that can be used to guide planners' selection of content to include in a curriculum. The criteria suggested the following aspects of the intended curriculum: *significance, utility, validity, and learnability*. Each of these criteria is briefly explained within the context of the secondary school mathematics curriculum.

The content included in a curriculum should be *significant* in terms of concepts and principles, needs and interests of students as well as covering problems and issues in the students' environment. These criteria can also be perceived as emphasising the relevance of what students learn that they should suit their cognitive and affective domains. This means that besides the useful applications of content, mathematics learning should be cognitively challenging to the students as well as provide them with aesthetics. Aesthetics rest on simplicity, insightful step, fruitfulness and revelation that can bring joy to a student's mind when successfully undertaking a mathematical challenge (Rota, 1997).

Utility refers to the usefulness of curriculum content to students and society at large. For instance, mathematics is a cumulative and vertically structured discipline. The totality of the accumulated mathematical knowledge determines success to learn with understanding higher order concepts. Similarly the type of mathematical understanding that is useful in the workplace should be determined and included in the core curriculum in order for school leavers to meet the mathematical expectations of employers. The content to be included in a curriculum needs to be checked and updated from time to time to determine its accuracy

so that it remains *valid*. This process ensures that the information passed on to students is up-to-date, authentic and obtained from credible sources. *Learnability* refers to the requirement that the curriculum content should be suitable to the cognitive development of students of a particular age group so that it can stimulate their thinking, interests and curiosity for them to be motivated to attend school.

National priorities can differ from one country to another but the above criteria can act as guidelines for deciding what content to include or exclude in a mathematics curriculum. It is against these benchmarks that we took for granted that the content excluded in the mathematics curriculum may have not met the above four requirements or may meet any one of them. Due to the overcrowded time to attend fairly equal to all aspects that are conceived important to achieve the national goals of a subject, some content has to be excluded. The theoretical framework of significance, *utility*, *validity*, and *learnability* also gave us shed light to some of the issues that might be used to assess teachers' perceptions towards mathematical concepts excluded in the national curriculum and on what basis these perceptions are thought of. However, not all the criteria could be covered on the assumptions we made in relation to mathematics concepts excluded in the curriculum.

Context of the study

The ideas for this paper emanated from the concepts of reflection, rotation and matrix multiplication that were intended for presentation at the 17th annual Association for Mathematics Education of South Africa (AMESA) conference. In response to the intended conference paper, sent earlier to be reviewed, one of the reviewers felt that matrix multiplication was not covered in the grade 12 national curriculum statement in South Africa and, therefore, the paper would not be relevant to teachers who would constitute a larger part of the conference attendees. However, another reviewer challenged this view suggesting that:

My review is mindful that the AMESA conference is not an academic and research conference, but one that is grounded in practice. Most participants are teachers who are seeking ideas and stimulation for improving their practice. In light of this, this paper is appropriate and presentable (Anonymous Reviewer).

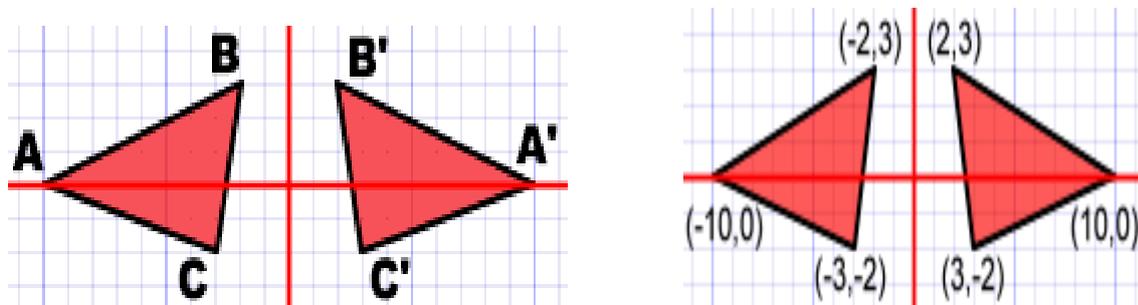
The paper was accepted for presentation and we seized the opportunity to find out how mathematics teachers would react to our two research questions, given the contradictory views from the conference reviewers.

The conference presentation

Part of the AMESA conference presentation is shown below. A typical issue was one requiring generalization of reflection transformation in the y -axis. Inductive reasoning

where a specific case was used leading to a general matrix of reflection in the y -axis was approached as illustrated below.

Figure 1: Reflection of corners of a triangle in the y -axis



A point-wise generalisation can emerge from using figure 1 to notice that a general point $\langle a; b \rangle$ reflected in the y -axis $\rightarrow \langle -a; b \rangle$. From this generalisation a pattern can be noticed that during reflection in the y -axis the coordinates of x change signs and those of y remain unchanged. Students can discuss this parsimonious conclusion and on their own and can make an intelligent guess to establish the case for reflection in the x -axis.

Determining a general matrix for reflection in the y -axis

During the symbolic representation learners can abstractly perform the process of reflection without using diagrams. Mere changing signs to determine the coordinates of a point requires verification in order to challenge fast learners who may be impatient to work with visual diagrams. An algebraic analysis of the process involved may take the following argument:

Let the matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ reflect the points $(-2,3)$ and $(-10,0)$ in the y -axis to $(2,3)$ and $(10,0)$, respectively. It is important to note that matrices can be used to capture the transformations thus:

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix} \times \begin{bmatrix} -10 \\ 0 \end{bmatrix} = \begin{bmatrix} -10a \\ -10c \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix} \Rightarrow \begin{cases} -10a = 10 \Rightarrow a = -1 \\ -10c = 0 \Rightarrow c = 0 \end{cases}$$

$$\text{And } \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} -2 \\ 3 \end{bmatrix} = \begin{bmatrix} 2 \\ 3 \end{bmatrix} \Rightarrow -2a + 3b = 2; \text{ substituting } a \text{ by } -1; 2 + 3b = 2; b = 0$$

$$\text{Also } -2c + 3d = 3 \Rightarrow 0 + 3d = 3 \text{ and } d = 1; \text{ since } c = 0.$$

$$\therefore \begin{bmatrix} a & b \\ c & d \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$$

This means that to reflect a shape in the y-axis, one should multiply the coordinates of the

shape by $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$.

Testing this assertion yields $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} -3 \\ -2 \end{bmatrix} = \begin{bmatrix} 3 \\ -2 \end{bmatrix}$ which is the coordinate of the third corner of the reflected triangle in figure 1. Using similar procedure learners can find a transformation matrix for reflection in the x-axis. The same process as the one given above can be repeated or fast learners can make an intelligent guess to deduce such a matrix to

be $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$. Whichever way it is used learners should be able to discuss and convince each other of why this intelligent guess makes logical sense.

Reflection in the line $y = \pm x$ can similarly be established and generalised as shown below.

Reflection about the line $y = x$ swaps x and y , i.e. we have $x' = y$; $y' = x$. The matrix associated with reflection about this line is thus

$$M_{xy} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}.$$

Similarly, reflection about the line $y = -x$ swaps x and $-y$, i.e. we have $x' = -y$; $y' = -x$. The matrix associated with reflection about this line is thus

$$M_{-xy} = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}.$$

To be able to generalise the transformation matrices for reflection through a line passing through the origin and rotation through 90° the concept of matrix multiplication played a pivotal role. The matrix approach illustrated how the x and y ordinate were transformed from the original triangle to the image triangle.

Design of the study

A descriptive survey design was adopted for this study. The design was found suitable because it allowed us to describe systematically, factually and accurately the numbers of teachers attending our presentation, their reactions during the presentation and engaged in a dialogue after the presentation (Patton, 2002). Thus the study falls under the interpretative paradigm where (a) the number of mathematics teachers who attended our presentation may be perceived as popular (b) the comments made by teachers who attended the after presentation session made evaluative comments on the presentation that were considered as portraying the teachers' perceptions. During the twenty minutes question and answer session after the 40 minute presentation participants were requested to seek clarifications on unclear issues, ask questions or make comments on the presentation. This session provided useful narratives that portrayed the participants'

perceptions towards the contents of the presentation. At the end of the time allocated for the presentation some participants remained in the room to discuss with us their points of views regarding the presentation and making academic networks. We engaged in evaluative discussion on their sense of the presentation and their opinions on the content. The limitation of the design of the methodology was that the sample was self selected. The opinions of those who chose not to attend the presentation were not sought. Based on these sources of data the results are presented below.

Results

Our presentation was of the ten sessions which were slotted on the last slot of the fifth and last day of the conference. Based on our conference attendance experiences participants are often tired after attending a conference for five continuous days. Coupled with anxiety to travel back to different destinations away from Johannesburg, where the AMESA conference was held, we anticipated minimum attendance to our presentation. However, we were surprised to note that the presentation room was three quarter full. At the start 27 participants showed up but during the course of the presentation six of them left the room. Their reasons for leaving the room were not established. Attendance to our presentation was voluntary and participants were free to walk out when they felt they needed to do so. A handful of participants walked out of our presentation room and those who remained to engage in conversations with us for the purpose of networking or seeking more explanations were not coerced to do so but did that at their own choice. To preserve the anonymity of the participants in order to protect their identities, numbers are used to denote their contributions. We acknowledge that the reduction in numbers limited the sample. The verbal conversations that were made during question and answer session allocated after the presentation and the general discussion that ensued with few teachers who remained behind in the presentation room after the end of the one hour allocated for the presentation are reported below. The questions were spontaneous and not pre prepared

Issues that arose during question time

The comments that were voiced by those teachers who attended our presentation during the question time were generally positive. For instance a comment passed by Teacher 1 was positive thus:

Transformation geometry is generally a difficult concept to most students, partially because they do not understand the basic concepts. When presented using the three methods of verbal, pictorial and matrix, students may begin to understand them. The three methods can allow students to choose a method that they understand most to answer a question. The use of multiple representations can also give students room to check their obtained results using one method and verified using another. My worry arises from the fact that matrices are not taught in schools

and we don't have time to teach the concept to enable students to master them. The question of time forbids teaching what is not in the national curriculum statement (Teacher 1).

Teacher 2 expressed similar sentiments saying:

It looks like matrix methods are powerful to generalize transformations. One does not need to draw those diagrams as it is simple to use a relevant transformation matrix. It is not necessary to memorize a transformation matrix because they are easy to derive. What is critical on the transformation matrix approach is students' mastery to perform matrix multiplication and their ability to solve simultaneous equations. Still where do we get time to teach the extra concepts on the operation of matrices when they are not in the national curriculum statement? (Teacher 2)

Some teachers were concerned that they were not taught matrices when they were students themselves and therefore have no understanding of the topic.

Some of us were not taught matrices when we were students and it is difficult to grasp the concepts ourselves. I attended this presentation just to see how matrices can be used in transformation geometry; otherwise I have no idea of their operations. Perhaps one day when the topic of matrices is introduced in the national curriculum statement some workshops on upgrading our content on the topic can be organized (Teacher 3).

One teacher said:

I was torn in between whether to attend this session or not. Now I realize that I would have missed out. The curriculum in my Teacher Training did not include matrices. After attending this session, I am motivated to get a book from the library to learn about this concept. I think that some of my learners who like calculations might benefit using this method. The problem is that we teach what will be asked in the exam and I might not be able to teach this method (Teacher 6)

Conversations engaged after the presentation

At the end of the allocated time of the presentation everyone was free to move out and attend the closing ceremony that was organized in a different room. A handful of teachers (four of them) remained in the room asking for our details so that they could contact us for more clarifications on the topic. We captured this opportunity to ask them how they felt about our presentation given that matrices are excluded in the national curriculum statement. The responses of two of them are summarized below:

The presentation opened my scope on an alternative way of teaching transformation geometry. I think the concepts on matrices should appear in some text books even though they may not necessarily be in the national curriculum statement for teachers' enrichment. The South African national curriculum changes very often. We started off with National Curriculum Statement (NCS), this was replaced by the Revised National Curriculum Statement (RNCS) and now we are talking of Curriculum and Assessment Policy Statement (CAPS). CAPS or future curricular may introduce new concepts like matrices and where will we go if we avoid mathematical content because it is not in the curriculum statement? For me whether content is in the national curriculum statement or not, as a mathematics teacher, I have interest in new concepts that are associated with the subject because I anticipate that one day the concepts may be included in the national curriculum statement (Teacher 4).

Another teacher expressed positive attitude towards content excluded in the national curriculum statement arguing that:

I have interest in mathematical content whether it is in the national curriculum or not. The experience that I had with data handling concepts should not be repeated. During my school days the topic was not covered in the school curriculum in detail so I took it for granted that it will stay out of the mathematics classroom. When the topic was introduced in the mathematics curriculum statement I didn't know where to start because I had no basic knowledge. From this experience I have developed interest in any mathematical concept that I don't know to prepare myself for the future, just in-case it may be included in the national curriculum statement (Teacher 5).

These intercepts show the teachers' desire to learn and appreciate mathematics topics that are excluded in the national curriculum statement. The teachers' interests and appreciations were based on their optimism that curricular content is not fixed and the possibility that some concepts that are excluded in the national curriculum may be incorporated. In our view, as a way of preparing themselves for successful future teaching of any mathematics curriculum that they may be asked to implement the teachers developed curiosity and desire to learn new content that they may have access to. The perceptions that the above teachers' intercepts portray positive perceptions towards the topic of matrices even though it is excluded in the national curriculum statement.

Discussion

The intercepts above show that mathematics teachers who came to our presentation room had various reasons for attending. Some of the reasons were to "see how matrices can be used in transformation geometry, otherwise I have no idea of their operations" (Teacher 3)

and widening their “scope on an alternative way of transformation geometry” (Teacher 4). As postulated by Teacher 4 the interest in new concepts arose from beliefs that perhaps in future the topic can “be included in the national curriculum statement”. The sentiments expressed by these teachers fall under the utility value of mathematics (Ornstein & Hunkins, 1998). The utility values of mathematical content indicate the usefulness of the content to students and society at large.

The motives of students studying matrices is two-fold, namely, the topic is useful for their future learning in higher levels of mathematics, and secondly, the topic is useful for technological development. At elementary level matrices can be used quickly to solve linear simultaneous equations or be used to check on solutions of simultaneous linear equations obtained using another algorithm. The concept of determinant is a principal one in mathematics because it can easily be used to determine some properties. For instance if a system of linear equations has a determinant of zero (0), then such equations have no unique solution. This idea is also used to define the characteristic polynomial of a matrix that is used in finding the solutions of eigenvalue problems (Leon, 2006).

As also noted by Leon (2006) the determinant of a matrix is a powerful concept that occurs throughout mathematics and often appear in the analysis of scientific problems. For instance, matrices are used to solve problems in electronics, statics, robotics, linear programming, optimisation, intersections of planes and genetics (Bourne, 2008). These matrix applications in the identified technical fields are important for the scientific and technological development of a country that all students should be exposed to the concepts in order to increase their opportunities to take up lucrative careers in them. Realising these important utilitarian values of matrices, some countries include the topic early in elementary secondary school curriculum so that students can study the topic in a spiral way. The spiral curriculum recognises that mathematics is a cumulative and vertically structured discipline whose concepts cannot be learnt and understood during one appropriate or ideal level.

In a spiral curriculum, concepts are introduced at a simple level in the early grades, they are then revisited with more and more complexity and applications later as students study higher academic levels on the topic (Ornstein & Hunkins, 1998). The gradual in-depth study allows concepts to be developed from simplex to complex through covering content that is organised from simple components to complex components that depict interrelationships among the components. This arrangement is assumed to provide optimal learning that occurs when students are presented with easy, often concrete content which gradually increases the level of difficulty and abstractness. The strategy of a spiral curriculum is to improve continuity of studying a concept. Continuity of studying a concept is assumed to ensure that concepts, themes and skills are repeated as a student progresses through the

grades, thus developing deep understanding as the complexity of the concept deepens at the same time that the cognitive development of students increase.

The teachers' optimism that one day the topic of matrices may find space in the South African curriculum is genuine (Teacher 2 & Teacher 4). There are rapid changes in the mathematics curriculum that are caused by the intensity of technology that will render some content obsolete and others a priority. One example that can show that the mathematics curriculum can change in response to societal goals and needs can be drawn from algebra and statistics.

Traditionally algebra was introduced in grade 8 mathematics when students' reasoning capacity was assumed to be developmentally appropriate and socially relevant (Hussain, 2009). As the need for citizens to reason logically became a societal goal the reform curriculum makes algebra formally recognised at all levels of mathematics education. At lower levels algebra covers patterns, number sentences and at higher levels directed numbers, rules and properties, sequences, variables and equations are covered. In a similar way statistics was covered in such a way that students were given tasks involving "small organised data set to represent in a specific type of graph" (Wessels, 2008:1). A national goal for citizens to participate meaningfully in social and economic spheres such as census made the study of statistics and probability gain entry in the mathematics curriculum in the 1980s. By 2000 statistics and probability or data handling was a central component of most mathematics curricula covering vital aspects such as hypothesis testing and prediction. The two examples of algebra and statistics and probability can be used as a reflection that the study of school mathematics should be sensitive and respond to real world applications that prepare students for work places and tertiary level National Council of Teachers of Mathematics (NCTM, 2000). Sensitivity of these two fundamental goals of mathematics education make it imperative for careful decisions to be made from time to time about what to have students learn as the totality of mathematical knowledge continues to grow and new demands exerted on the subject.

Conclusion

This paper presents opinions or perceptions of mathematics teachers attending one conference organized by the teachers association in the country. This means that findings reported here cannot be generalized to mathematics teachers in South Africa. Furthermore, the *ad hoc* methods of data collection were restricted by the contexts at hand that forbade conducting in-depth interviews or use a variety of methods to assess the consistency of responses from the teachers. The optimism of the teachers whose responses are reported in the study can be used as a sign that the teachers were a unique group with keen interest in mathematics and a desire to teach the subject well. A statement such as "I have interest in new concepts in mathematics because I anticipate that one day the concepts may be included in the national curriculum statement so for me it doesn't matter whether content

is in the national curriculum statement” (Teacher 4) speak volumes of the love, interest and desire to understand the content of mathematics to a deep level.

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