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Affordances for connecting culture and Mathematics: Moving from curriculum to school textbooks

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Researchers have generally agreed that textbooks as a major conveyor of the curriculum play a dominant role in modern education scenes across different school subjects. The study analyzed a set of four learners' textbooks and their corresponding teachers' guides which are used as set books for teaching mathematics at Grade 9 level in South Africa. These textbooks were produced in response to the demands of the Grade R-9 National Curriculum Statement (NCS) policy document. A qualitative content analysis on how the recommendations in the policy document were further recontenxtualised in the pedagogic recontextualising field (PRF) by textbook authors into curriculum materials is presented. A vertical analysis approach was used, attending to the ways in which textbooks treat the idea of indigenous mathematical knowledge. Thus, it checks on the provided affordances for connecting culture and mathematics. Indications of affordances for connecting culture and mathematics are awash in the analyzed textbooks. However, authors had few examples from the learners' indigenous cultures but rich implementation ideas using foreign cultures. There is need for further research on where and how this indigenous mathematical knowledge can be extracted so as to be part of the textbooks' content.

Key words: Indigenous knowledge, culture, affordances, school textbooks.

INTRODUCTION

Mathematics textbooks have a strong ability to influence mathematical learning through influencing classroom practices (Stylianides, 2014; Fan, 2013). Textbooks are designed to assist teachers in structuring their teaching and suggest a pathway for learners to follow when exploring a topic (Johanson, 2005). Textbooks play a significant role in ways mathematics lessons are designed and delivered; their influence over the content of lessons; the instructional approaches; the quality of activities assigned for pupils, in classrooms and for homework; and learning outcomes and achievement (Alajmi, 2012; Törnroos, 2005; Weiss et al., 2003). In the context of curriculum reform, textbooks may be used as a roadmap to the implementation of curriculum change. Robitaille and Travers (1992) argued that a great dependence upon textbooks is perhaps more characteristic of the teaching of mathematics than any other subject. In relation to such importance, Sosniak and

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Perlman (1990) pointed out that the power of textbooks lies in their ability to serve as resources. Textbooks can provide an “organized sequence of ideas and information” to structured teaching and learning, which guide readers’ “understanding, thinking, and feeling” as well as “access to knowledge which is personally enriching and politically empowering” (Sosniak and Perlman, 1990: 440). Apple (1986) argued that it is the textbook which establishes so much of the material conditions for teaching and learning in classrooms and often defines what elite and legitimate culture to pass on is. Researchers’ conceptualization about the relationship between the textbooks and curriculum is particularly worthy to note. Textbooks, as curriculum materials, offer supplementary ideas for teaching. Howson (1995) pointed out that textbooks were one step nearer classroom reality than a national curriculum.

According to Stylianides (2014), textbooks can be analysed from various perspectives, among others the learners’ perspective, the teacher’s perspective or a mathematical perspective, thus examining a textbook’s potential to aid learning. In this article textbooks were analysed to find out how the textbook writers responded to the demands of South Africa’s Grade R-9 National Curriculum Statement (NCS) policy document. The NCS recommends the incorporation of indigenous knowledge in mathematics education.

South Africa has embarked upon a curriculum that strives to enable all learners to achieve their maximum potential (Revised National Curriculum Policy, Department of Education, 2002). Policy statements for Grades R-9 Mathematics envisage learners who will “be culturally and aesthetically sensitive across a range of social contexts” (Department of Education, 2002: 2). In this regard, the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives (Department of Education, 2011). Interestingly, some assessment standards expect learners to be able to solve problems in contexts that may be used to build awareness of social, cultural and environmental issues. The NCS challenges educators to find new and innovative ways to reach learners from diverse cultures in their mathematics classrooms. Valuing indigenous knowledge systems is one of the principles upon which the NCS is based. Part of the teacher’s work involves coming to an argument for ethnomathematics as a cultural way of doing mathematics. The NCS calls for radical teaching practice changes on the part of the teachers in order to see mathematics incorporated in the real world as a starting point for mathematical activities in the classroom (Madusise, 2013, 2015). Therefore, for there to be a real possibility of implementing such kind of classroom activity, there is need to investigate the mathematical ideas embedded in cultural practices, ethnic and linguistic communities of the learners. Khisty (1995) argues that learners of all background would benefit from the opportunity to learn about and identify with their rich mathematics heritage and on-going cultural practices.

METHODOLOGY

Bernstein (1996, 2000) described pedagogic device as a system of rules that regulate the processes by which specialized knowledge is transformed to constitute pedagogic discourse (in the forms of curricula and selected texts). The pedagogic device (Bernstein, 2000) is made up of three fields: the field of knowledge production, the field of recontextualisation, and the field of transmission. Each of these fields operates by a set of rules which inform what knowledge gets privileged, what happens to this knowledge as it is recontenxtualised into curriculum and transmitted through pedagogy and assessment. Of interest to this article is the field of recontextualisation, in this case the academy where certain rules “select and de-locate” (Bernstein, 1990: 185) from the field of knowledge production what counts as educational knowledge. For Bernstein, the movement of knowledge from one site to another occurs through the process of recontextualisation.

Recontextualisation is influenced by two fields; the official recontextualising field (ORF) and the pedagogic recontextualising field (PRF). Through the ORF the state and its delegates (state education agents such as curriculum advisors) operate at a generative level to legitimise official pedagogic discourse (that is the curriculum e.g. the NCS). Therefore any curriculum represents the official pedagogic discourse produced in the official recontextualising field (Bernstein, 1996). In this case knowledge selection from the field of production is also influenced by the political needs of a particular state at a particular time. This undergoes further recontextualisation through the PRF, when policy is interpreted and used as for example in the construction of textbooks or in professional development programmes. Both the curriculum text (official pedagogic discourse) and the textbook or professional development text are recontenxtualised in the reproduction-text at the level of the teacher’s pedagogic practice in the classroom.

Specifically the study from which this article is premised analyzed the NCS for Grades R-9 to explore what recommendations are put forward in the policy document concerning the incorporation of indigenous knowledge systems in the teaching and learning of school mathematics (Madusise, 2013). The recommendations were further checked through analyzing a set of four Grade 9 textbooks which Grade 9 teachers were using as set books as well as reference books. The selected Grade 9 textbooks and their accompanying teachers’ editions were said to have been developed for the National Curriculum (as indicated on the covers of the textbooks). These textbooks were chosen with the anticipation that they adhere to the goals of the NCS. Affordances for connecting culture and mathematics were checked in the textbooks, checking how the authors managed to move from curriculum statements to school textbooks.

A qualitative method approach involving the descriptive survey research design was used. Qualitative research is contextual and subjective as opposed to generalizable and objective, and as such has generated considerable debate around issues of reliability and validity. However, threats to validity and reliability can never be entirely erased; at best the researcher could strive to minimize invalidity. Reliability, on the other hand, deals with whether the results are consistent with the data collected. It may be useful as an indicator of *trust worthiness* of research results. Reliability simply means dependability, stability, consistency and accuracy as described by Atebe (2008). Validity should then be seen as a matter of degree rather than as an absolute state (Gronlund, 1981). Trustworthiness is established by the researcher’s attempts to demonstrate the robustness of the method (Winter, 2000). To confirm or ensure trustworthiness of the results, the researcher used excerpts from the NCS and textbooks. Excerpts from textbooks were analyzed against excerpts from the NCS checking whether or not they were conforming to the curriculum demands. The ‘what’ from the curriculum was checked against the ‘how’ from the textbooks (see the analytical framework).

Analytical framework

The examination of the documents was guided by the ‘what’ and ‘how’ questions. The ‘what’ was attending to the recommendations presented in the documents referring to what content and relations to be transmitted. The ‘how’ referred to the degree of implementation of the recommendations, that is the form to be taken by the transmission of these contents and relations, examining the control the teachers and pupils possess over the selection, organization, and pacing of cultural mathematical knowledge.

Some official pedagogic discourses explicitly define the ‘what to teach”, “how to teach” and assessment criteria (strongly framed), giving teachers and learners little control over the selection, sequencing and pacing of the transmission and acquisition (Bernstein, 1996). However, in other official pedagogic discourses, the “what to teach” and “how to teach” are implicit, giving learners more control of what they want to learn. In such a scenario, teachers play the role of facilitators. The analyzed documents were checked against these two dimensions. Bernstein gives primacy to the recontextualising field, seeing it as a mediating context governing the fundamental autonomy of education” (Bernstein, 2000:33). What approach[es] find[s] a place in the classroom will largely rely on the power relations between the official recontextualising field (ORF) and the pedagogic recontextualising field (PRF). Of interest to this article is the checking of these powers and control relations espoused in the ORF and PRF, with respect to the recommendations made in the ORF and how these recommendations were recontenxtualised in the PRF. The vertical analysis approach was used. Mesa (2004) defined vertical analysis as an approach attending to the ways in which textbooks treat a single mathematical concept, that is, how a particular idea or aspect of interest is reflected in the textbooks. The single treated idea in this study was the idea of indigenous mathematical knowledge.

RESULTS AND DISCUSSION

Analysis of the national curriculum statement for Grades R-9: Mathematics

The adoption of the Constitution of the Republic of South Africa (Act 108 of 1996) provided the basis for curriculum transformation and development in South Africa (Department of Education, 2002: 1). One of the aims of the Constitution is to heal the division of the past and establish a society based on democratic values, social justice and fundamental human rights. The development of a new policy is always situated within a particular historical, economic, social and political context (Taylor and King, 1997). This is explicitly so with the NCS. The Manifesto on Values, Education and Democracy (RSA DoE, 2001b) identified strategies which find expression in the NCS to familiarize learners with the Constitution. One of the strategies is ‘to learn about the rich diversity of cultures, beliefs and world views within which the unity of South Africa is manifested’.

Valuing indigenous knowledge systems is among the NCS principles. “Indigenous knowledge systems, in the South African context refer to a body of knowledge embedded in African philosophical thinking and social practices that have evolved over thousands of years (Department of Education, 2003:4). Indigenous mathematical knowledge is conceived as part of this political vision. This is because the NCS has infused indigenous knowledge systems in the subject statements as reflected in the learning outcomes and their respective assessment statements. It acknowledges the rich history and heritage of the country as important contributors to nurturing the values contained in the Constitution (Department of Education, 2003: 4) (Table 1). From the above narratives the NCS is advocating for inclusion of indigenous knowledge in the assessment standards. The Grade 9 mathematics learning area has five learning outcomes. Out of these five learning outcomes, the inclusion of indigenous knowledge is argued for in the assessment standards of four learning outcomes. This indicates the importance which is being attached to the value of indigenous knowledge in mathematics education. The NCS can be said to be supporting school mathematics through its history and the various applications of mathematics in different cultures around the world, sending a message that curriculum material developers should seek and include historical elements as well as cultural elements in their texts in order to enrich the teaching of various lessons. This quest and its findings does not only target into enriching the teaching of various lessons, but also in discovering facts and elements that can encourage a deeper understanding of mathematics, how some mathematical ideas evolved, how society influenced their development, how results influenced society as well.

The NCS’s assessment approach is in line with D’Ambrosio (1985)’s notion of ethnomathematics. In his seminal paper, D’Ambrosio (ibid) defined ethnomathematics as the bridges that connect historians and anthropologists from one side and mathematicians from the other, in order to identify the different kinds of mathematics that exist. From the above NCS extracts, it can be recognized that the role of mathematics in education is not just to provide pupils with the scientific tools – which are important - but also to answer questions such as “where does mathematics come from?”, and “why and how did it come about?”, providing the learners with a more understanding of mathematics as a science and as a human endeavour. Therefore, the NCS policy strongly recommends the inclusion of history and culture in the assessment programme for teaching mathematics, thus, providing affordances for connecting culture and mathematics.

Textbook analysis

To analyze the textbooks the method used by Valverde et

Table 1. Extracts of what is proposed in the NCS with respect to indigenous knowledge.

Learning outcomes	**Assessment standards**
i). Numbers, Operations and Relations: The learner will be able to recognize, describe and represent numbers and their relationships	We know this when the learner: i). Describes and illustrates the historical development of number systems in a variety of historical and cultural contexts (including local)
ii). Patterns, Functions and Algebra: The learner will be able to recognize, describe and represent patterns and relationships, as well as solve problems using algebraic language and skills.	We know this when the learner: i). Investigates, in different ways, a variety of numeric and geometric patterns and relationships by representing them, and by explaining and justifying the rules that generate them (including patterns that are found in natural and cultural forms and patterns in learner's own creation) ii). Constructs mathematical models that represent, describe and provide solutions to problem situations (including problems within human rights, social, economic, cultural and environmental).
iii). Space and Shape (Geometry): The learner will be able to describe and represent characteristics and relationships between two-dimensional shapes and three-dimensional objects in and a variety of orientations and positions.	We know this when the learner: i). Recognises, visualizes and names geometric figures and solids in natural and cultural forms and geometric settings ii). Describes the interrelationships of the properties of geometric figures and solids with justification in contexts hat include those that may be used to build awareness of social, cultural and environmental issues.
iv). Measurement: The learner will be able to use appropriate measuring units, instruments and formulae in a variety of contexts.	We know this when the learner: i). Solves problems – including problems in contexts that may be used to develop awareness of human rights, social economic, cultural and environmental issues – involving known geometric figures and solids in a range of measurement contexts. ii). Describes and illustrates the development of measuring instruments and conventions in different cultures throughout history.

Table 2. Blocks for the vertical analysis of textbooks.

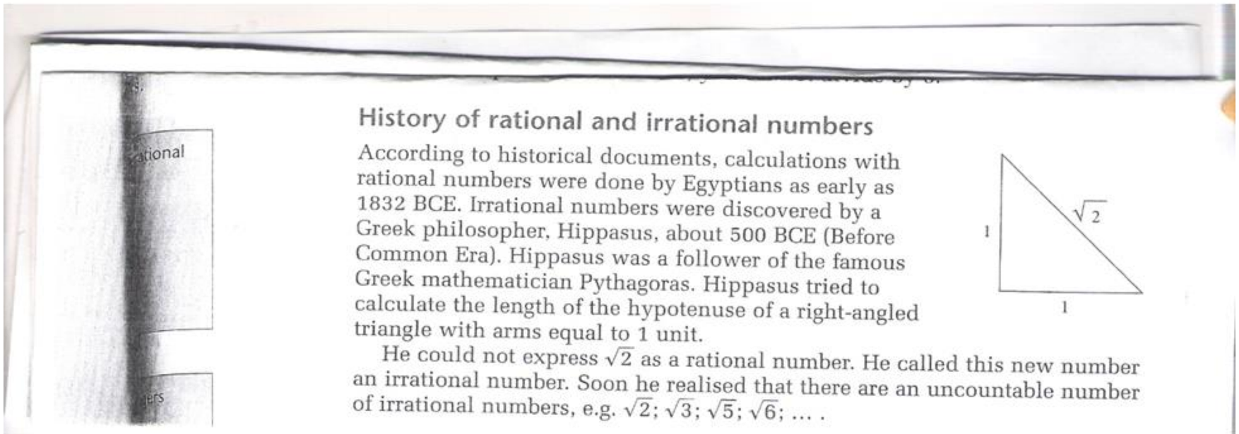
Block to examine	**Examples of tasks to examine**
Narratives	Use of paragraphs to explain concepts and topics involving cultural knowledge through description and discussion
Exercises and questions	These engage learners more actively than narrative blocks. They provide instructions and opportunities to acquire particular skills
Activity elements	These are segments of textbooks that contain instructions and suggestions for learner activities. Often they contain instruction for conduct of some "hands-on" experiences. Activities prescribe an intended dynamic use of the textbooks and inherently demand an active learner" (Valverde et al., 2002: 142)
Support for teachers	Information to teachers on how to incorporate indigenous knowledge in the teaching and learning of mathematics

al. (2002) was adapted. The content on cultural knowledge selected from the textbooks was divided according to narratives, exercises and questions, and activity elements. These adapted blocks were used as units of analysis (Table 2).

Cultural mathematical ideas within the narratives in the learners' textbooks

To examine cultural knowledge within the narratives in the selected learners' textbooks, the researcher identified and reported on: (a) how mathematical concepts were introduced using cultural knowledge, (b) whether the given history of mathematical concepts was local or foreign, (c) whether different cultures were represented in the narratives, and (d) whether indigenous ideas were explored within different representations such as diagrams, tables and graphs. For ethical reasons, the textbooks were referred to as books 1, 2, 3 and 4 instead of referring to them by title or author's name.

This narrative (Figure 1) provides a brief history on the development of irrational numbers. The failure to calculate the length of the hypotenuse of the right-angled triangle led Hippasus, the Greek mathematician to the concept of irrational numbers. This suggests that



History of rational and irrational numbers

According to historical documents, calculations with rational numbers were done by Egyptians as early as 1832 BCE. Irrational numbers were discovered by a Greek philosopher, Hippasus, about 500 BCE (Before Common Era). Hippasus was a follower of the famous Greek mathematician Pythagoras. Hippasus tried to calculate the length of the hypotenuse of a right-angled triangle with arms equal to 1 unit.

He could not express $\sqrt{2}$ as a rational number. He called this new number an irrational number. Soon he realised that there are an uncountable number of irrational numbers, e.g. $\sqrt{2}$; $\sqrt{3}$; $\sqrt{5}$; $\sqrt{6}$; … .

Figure 1. An example of how the development of rational and irrational numbers was introduced in Book 1, page 3.

Patterns relating to our culture

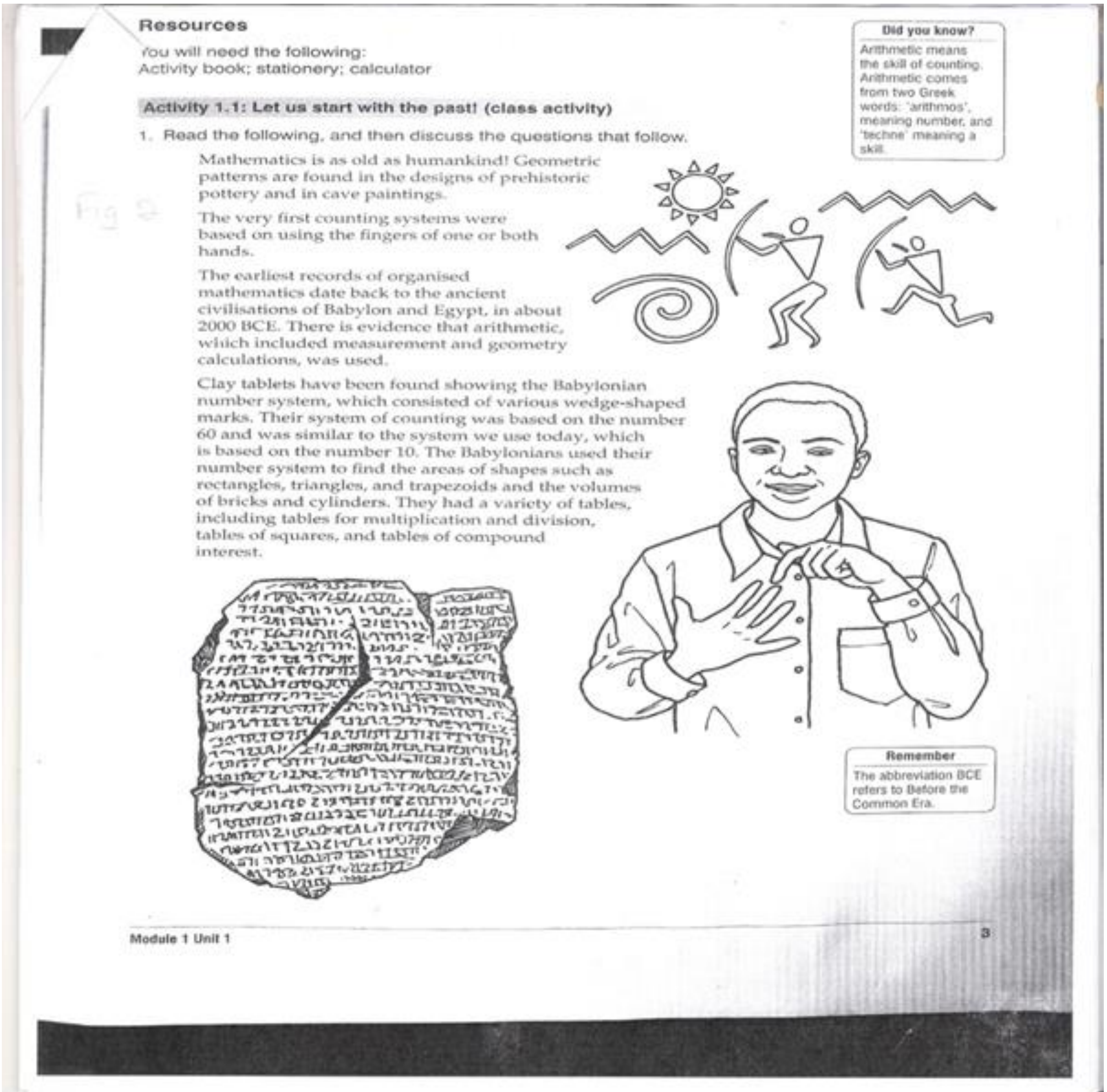
Our nation values its diversity of cultural heritage. People often express their cultural values by using geometric figures to decorate their houses, fabrics and artefacts. Some of these decorations tell stories about cultures that have evolved over many years. The people of our nation are proud of their own individual cultures and the values that go with them, but they also all work together to develop a unique South African culture.

Figure 2. Some geometric figures from Book 1, page 130.

mathematical ideas were developed to solve encountered problems. Generally societal needs led to additional number groups in number systems. This background information helps the learners to realize that mathematics was developed through cultural human activities aimed at solving encountered problems. Figure 2 gives both a narration on how some geometrical figures were used as decorations in the South African cultures and diagrammatic representation of geometric figures. Such decorations can be used to illustrate transformations. This suggests that some mathematical ideas also evolved from the South African cultures, thus making mathematics culture-laden.

It was interesting to note that by citing South African cultures, the authors were suggesting the possibility of some mathematical concepts having evolved from South African cultures. This is in line with one of the NCS's principles – cultural consciousness. However, the same authors were not consistently using South African cultures; a close analysis of the textbook reveals only two situations where South African cultures were cited in all the thirteen cultural narratives used in the textbook.

Figure 3 gives the historical developments of some mathematical concepts in different cultures. This information may help learners to understand that different cultures developed different mathematics and also helps



Resources

You will need the following:
Activity book; stationery; calculator

Activity 1.1: Let us start with the past! (class activity)

1. Read the following, and then discuss the questions that follow.

Mathematics is as old as humankind! Geometric patterns are found in the designs of prehistoric pottery and in cave paintings.

The very first counting systems were based on using the fingers of one or both hands.

The earliest records of organised mathematics date back to the ancient civilisations of Babylon and Egypt, in about 2000 BCE. There is evidence that arithmetic, which included measurement and geometry calculations, was used.

Clay tablets have been found showing the Babylonian number system, which consisted of various wedge-shaped marks. Their system of counting was based on the number 60 and was similar to the system we use today, which is based on the number 10. The Babylonians used their number system to find the areas of shapes such as rectangles, triangles, and trapezoids and the volumes of bricks and cylinders. They had a variety of tables, including tables for multiplication and division, tables of squares, and tables of compound interest.

Did you know?
Arithmetic means the skill of counting. Arithmetic comes from two Greek words: 'arithmos', meaning number, and 'techne' meaning a skill.

Remember
The abbreviation BCE refers to Before the Common Era.

Module 1 Unit 1 3

Figure 3. Narrative statements from Book 2, page 3.

them to realize the connection between culture and mathematics, making mathematics a product of different cultures. This is in line with the NCS's definition that "mathematics is a product of investigation by different cultures". Joseph (1991 quoted in Joseph, 2000) emphasizes the fact that mathematics is usually taught from a purely Euro-centric point of view, focusing on the development of sciences in Europe, as if the rest of the world never contributed. Contributions of the Egyptians and the Babylonians towards the development of mathematics are reflected in the narratives. Although the narratives are suggesting a possibility of mathematics having developed from Africa, narratives from South African cultures, for example, geometry patterns found in Ndebele paintings and beadings would be more appealing to the local learners. There are also patterns found in the Venda clothes. These could have presented the learners with local cultural knowledge.

Interestingly, it was noted that, in all the four analyzed textbooks, indigenous ideas were explored within different pictorial representations (Table 3). These symbolic and pictorial representations provide opportunities for multiple representations of ideas. Grouws (1992) and Hiebert (1986) cited in Mayer et al. (1995) argue that it is important to help students build connections between multiple representations. Multiple representations of problem-solving procedures might usefully include all symbolic, verbal and visual

Table 3. Representations used in the textbooks.

Textbook number	Type of representation
Book 1	The tower of Hanoi used to illustrate number patterns using golden discs placed on the needle at the centre of the tower, p. 23. Diagrams representing the Chokwe Sona sand drawings, p. 29-32. Geometric shapes on South African paintings, p. 130. Animal pictures demonstrating patterns in the animal world, p. 132-133.
Book 2	Geometric patterns in cave paintings and clay tablets in Babylon, p. 3 Egyptian pyramids, p. 5 Geometric patterns in buildings and the mandala Buddhism circular design, p. 142.
Book 3	Polygons in Islamic architecture used to illustrate transformations, p.71 Photograph of a woman seeing herself in the mirror illustrating reflection, p.63 Egyptian number symbols, p. 2
Book 4	Symmetrical shapes, p. 136 Egyptian pyramids with square bases used to demonstrate Pythagoras theorem, p. 271

representations, with content embedded within familiar situations so that the symbolic, verbal and visual representations are interconnected. This need for textbooks to make connections explicit and to support the making of connections through multiple representations is quite satisfied in all the four analyzed learner's textbooks. This also suggests that cultural knowledge has different forms of representations which can be used to assist learners' understanding. Use of pictorial representations promotes observation and analyzing skills advocated in the NCS.

Cultural knowledge within exercises, activities, investigations and summative assessments in learner's books

In analyzing the exercises, activities, investigations and summative assessments the researcher checked on how they can possibly engage learners in mathematics. Also checked were the activities' affordances of learners' learning of cultural mathematical knowledge and the support of the development of skills and values advocated for in the NCS (Figure 4).

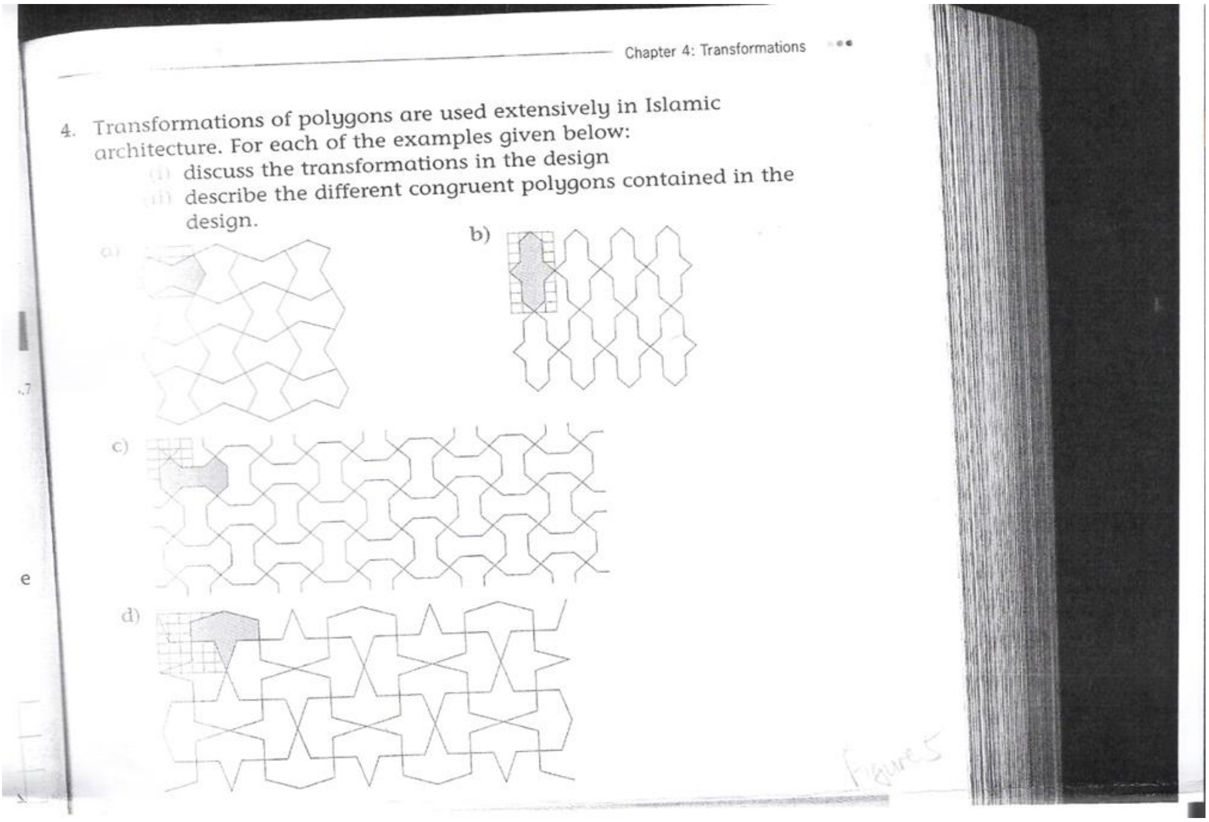
An engagement with the task can make learners competent in isometric transformations. The task covers quite adequate knowledge of isometric transformations. Besides the intended work on transformations, the pictorial representation can also be used in teaching congruence of shapes, lines and order of symmetry, and rotational symmetry. Therefore, the architecture can provide a smooth entry into several mathematical concepts. By engaging the architecture, learners can also engage in deep mathematics. Such cultural contexts can enhance the mathematics learning environments.

However, the authors could have diversified and in addition also used similar examples from local cultures, especially the Ndebele culture whose paintings are quite rich in geometric shapes. This can help to align textbook content to one of the goals of NCS, that of using local culture as demanded by learning outcomes' assessment standards. Doyle (1988) argues that the tasks teachers assign to students influence to a large extent how students come to understand the curriculum domain.

Clearly the activity can engage learners in a deeper understanding of the history of number systems (Figure 5). In working out the activity, learners may learn more about the number symbols in the Egyptian number system and may also come up with number systems of other cultures including their own cultures. Learners may appreciate the idea that even their cultures were capable of developing mathematics. These tasks may influence to a large extent how learners think about the evolution of mathematics. This premises that tasks, most likely chosen from textbooks, influence to a large extent how learners think about mathematics and come to understand its meaning (Pepkin, 2004). Indeed, Henningsen and Stein (1997), cited by Pepkin (2004) argue that:

The tasks in which students engage provide the contexts in which they learn to think about subject matter. Thus, the nature of tasks can potentially influence and structure the way students think and can serve to limit or broaden their views of the subject matter with which they are engaged (p. 525).

The activity also provides an opportunity for learners to learn about mathematics even outside the mathematics classroom since it demands the search for the history of numbers in the learners' cultures. This history can be searched from community elders or from cultural village employees. The acquisition of such knowledge can enable the learner to develop an awareness of the


Chapter 4: Transformations

4. Transformations of polygons are used extensively in Islamic architecture. For each of the examples given below:
(i) discuss the transformations in the design
(ii) describe the different congruent polygons contained in the design.

a) b) c) d)

Figure 4. Transformations of polygons in Islamic architecture in Book 3, page 71.

diverse historical, cultural and social practices of Mathematics, thus aligning the teaching and learning of Mathematics with its learning goals outlined in the NCS that of connecting mathematics and culture. Therefore the task can be engaging and motivating for the intended learner population.

In the task, learners are encouraged to work with partners, thus encouraging collaborative work. The task also promotes learner-centred approaches where the teacher's role is that of a facilitator. The task can groom learners for research.

Activity on numbers

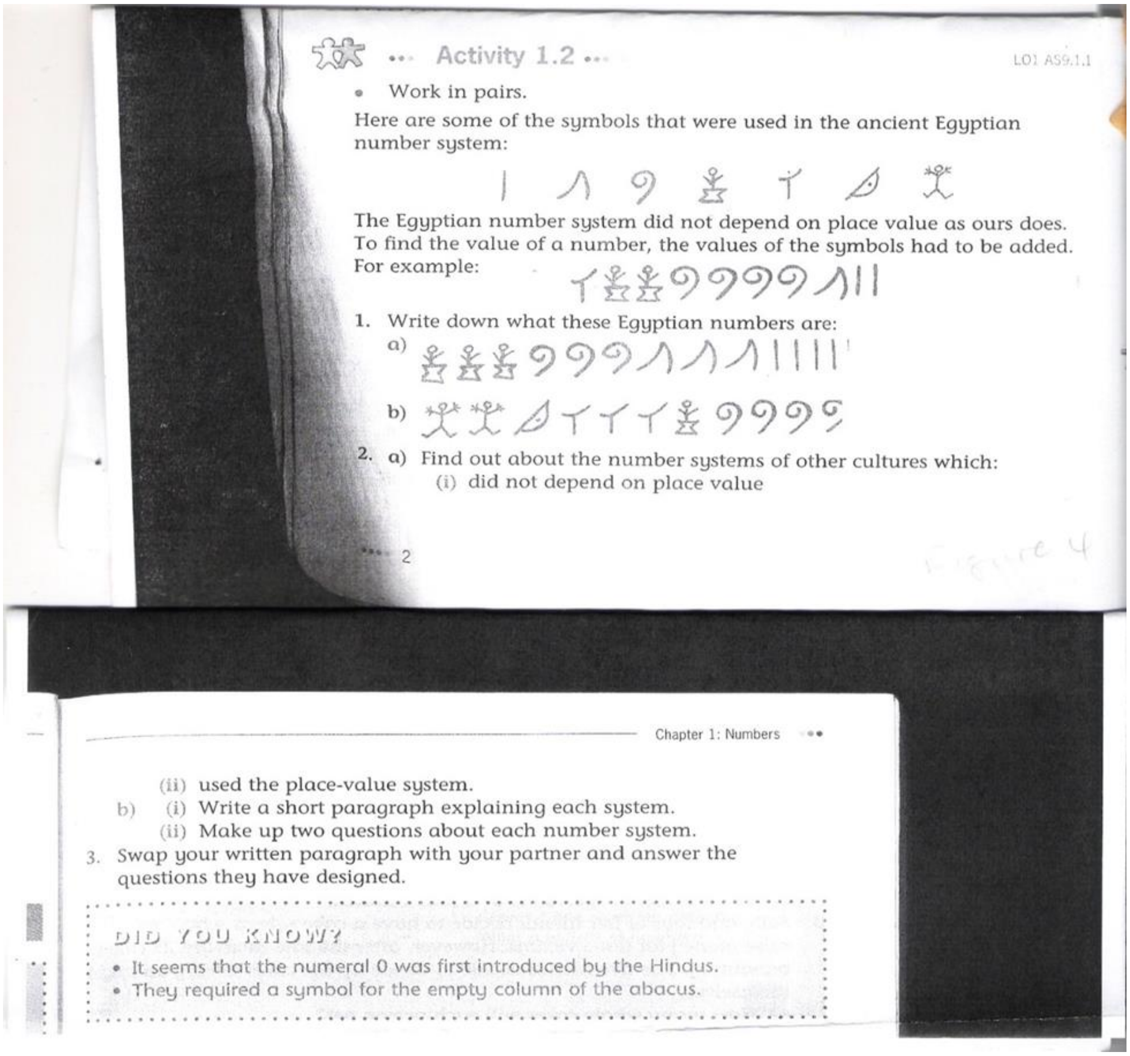
Like the other analyzed activities, the above activity can groom learners to be young researchers. Research work can make a measurable difference in the learner's learning where learners are now expected to learn on their own, thus placing the control in the learners' hands. By engaging in the activity, learners can learn more about mathematics in relation to their cultures and in comparison with other cultures (Figure 6).

It was discovered that all the four textbooks have very few questions on local cultural knowledge. Almost all the questions on cultural mathematics in the textbooks had same format. Questions engage learners into some sort of research on cultural mathematics, thus encouraging learners to talk about mathematics even outside the classroom. For the few presented questions, the selection of instructional knowledge appears to be weakly framed; learners have control over the selection of instructional knowledge. As the activities are sort of projects, learners can work at their own pace. This theory of instruction legitimized in the textbooks provides affordances for connecting culture and mathematics and opportunities for enquiry teaching and learning approaches.

Analysis of teachers' guides

All the teachers' guides for the four analyzed learner's books contain an introduction section where a precise overview of the NCS expectations is provided. In book 3, at the beginning of each learning outcome, a table showing knowledge, skills and values to be promoted is provided. The information on the table reminds and further guides the teachers on the expectation of the NCS. For example the values related to indigenous knowledge under the Learning Outcome, "Numbers, operations and relationships, were:

(i) Appreciate the historical development of number



Activity 1.2 LO1 AS9.1.1

- Work in pairs.

Here are some of the symbols that were used in the ancient Egyptian number system:

The Egyptian number system did not depend on place value as ours does. To find the value of a number, the values of the symbols had to be added. For example:

1. Write down what these Egyptian numbers are:
   a)
   b)
2. a) Find out about the number systems of other cultures which:
   (i) did not depend on place value

2

Chapter 1: Numbers

(ii) used the place-value system.

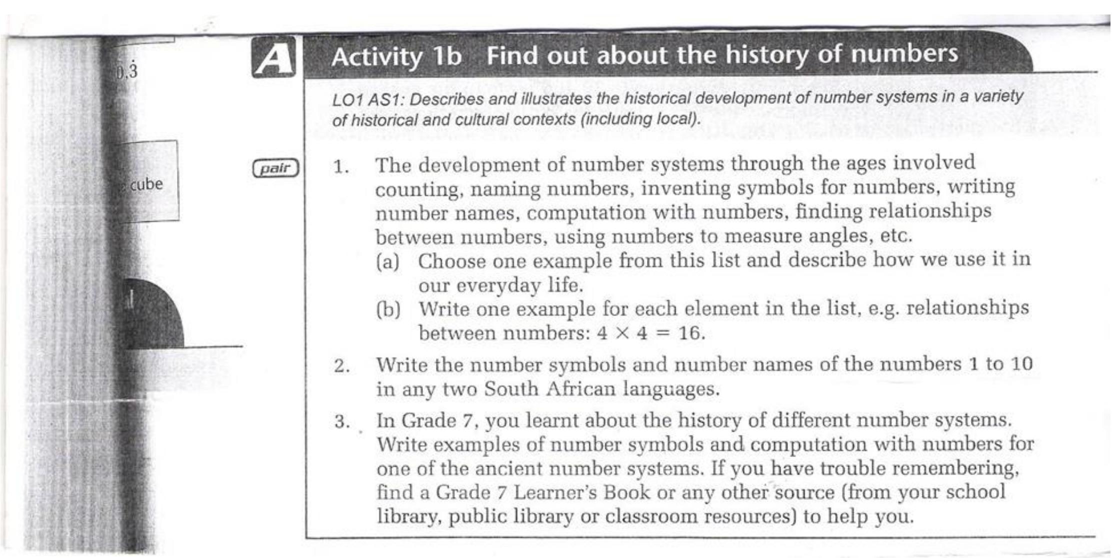
b) (i) Write a short paragraph explaining each system.
(ii) Make up two questions about each number system.

3. Swap your written paragraph with your partner and answer the questions they have designed.

DID YOU KNOW?

- It seems that the numeral 0 was first introduced by the Hindus.
- They required a symbol for the empty column of the abacus.

Figure 5. Activity on number systems: The history of numbers from Book 3, page 2-3.



A Activity 1b Find out about the history of numbers

LO1 AS1: Describes and illustrates the historical development of number systems in a variety of historical and cultural contexts (including local).

pair

1. The development of number systems through the ages involved counting, naming numbers, inventing symbols for numbers, writing number names, computation with numbers, finding relationships between numbers, using numbers to measure angles, etc.
   (a) Choose one example from this list and describe how we use it in our everyday life.
   (b) Write one example for each element in the list, e.g. relationships between numbers: $4 \times 4 = 16$.
2. Write the number symbols and number names of the numbers 1 to 10 in any two South African languages.
3. In Grade 7, you learnt about the history of different number systems. Write examples of number symbols and computation with numbers for one of the ancient number systems. If you have trouble remembering, find a Grade 7 Learner's Book or any other source (from your school library, public library or classroom resources) to help you.

Figure 6. Activity on the history of numbers from Book 1, page 3.

systems; and
(ii) Appreciate the importance of human rights, social, economic and environmental issues.

However, a further analysis of the supporting content revealed that the content on indigenous mathematical knowledge was left for the teacher and his\her learners' research work. Content given was mainly on the development of number systems in Egypt. The suggested application on the content on local number systems was a class discussion on number systems known by learners. The authors should have made an effort to research on at least one system (and leave the rest for learners' research work) which was used in the local cultures like they did with the Egyptian numbers to show the learners that the number systems in their cultures were also worthy textbook material. This way of presentation when it comes to indigenous knowledge seemed to be the norm in all the analyzed teacher's guides. Where presentations hints on cultural knowledge are given, the authors refer to other nations. This is illustrated by the suggestion such as:

(i) If you have pictures or interesting articles (for example a book with the chapters marked in Roman numerals), bring these to show your learners (Book 2 teacher's guide, p. 5).

The above is a presentation hint on the history of number systems. This sends a message that textbook authors are not well-versed with the local cultural mathematical knowledge since it is not documented. Besides lack of sufficient content on cultural mathematical knowledge evolving from the South African cultures the teachers' guides provide teachers with precise guidelines on possible activities (where the content for activities is made open for further research by teachers and learners) and assessment criteria. The theory of instruction which is legitimized in the guides is mainly weakly framed, suggesting a higher degree of learner's participation.

Conclusion

The analysis of the NCS Grade R-9 Mathematics shows that the curriculum, through its intended content and theory of instruction, creates many opportunities for the integration of indigenous knowledge into school mathematics. The NCS evinces weakly classified inter-discursive relations in terms of integration of indigenous mathematical knowledge. It clearly recommends the use of local cultural knowledge in the teaching and learning of mathematics, promoting the view that mathematics has been or is a human activity which every culture was or is responsible for developing. In response to this view, curriculum statements open up opportunities for contextualising the teaching and learning of mathematics. While there are indications of affordances for connecting culture and mathematics, lack of sufficient indigenous knowledge content in the textbooks may be detrimental to the successful implementation. The analysis of learners' textbooks and teachers' guides indicates insufficient local cultural mathematical knowledge content but rich implementation ideas using foreign cultures. The usefulness of the suggested implementation ideas depends on the teachers' commitment to go an extra mile searching for the indigenous mathematical knowledge from their learners' cultures.

RECOMMENDATIONS

It looks like there is much to be done, concerning indigenous mathematical content, at the pedagogical recontextualising field for the good ideas proposed by the NCS to be fully realized. This leads to the question; where and how can this indigenous mathematical knowledge be extracted so as to be part of the textbooks' content. In order to provide an answer to this question there is need for further research on cultural sources of indigenous mathematical knowledge. The authors of the analyzed Grade 9 mathematics textbooks seem not to be having sufficient indigenous mathematical content knowledge to incorporate in their textbooks. The frequent cultural content knowledge espoused in the four analyzed sets of textbooks was from the Egyptian, Roman and Babylonian contexts, sending a message that an adequate search of indigenous mathematical content by the authors to include in their textbooks is needed.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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