# Exploring the mathematics that children read in the world: A case study of Grade 8 learners in a South African School

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## Abstract

This paper presents a qualitative study in which an attempt was made to extend the debate surrounding the use of real life contexts to make mathematics more meaningful and real. The study investigated Grade 8 learners' knowledge of number, understanding of number concepts and the kinds of connections they make between number and the context in which number is used. An important aspect of the study's methodological approach involved an examination of the comments that learners made about what they said they know about number. A response to the question: "Why is the number in the picture?" provided a framework for establishing how learners saw relationships between number and the context in which numbers are used. A face scenario with four questions was given to learners to elicit these relationships. Results pointed to the usefulness of real life contexts as tools that have a central role in uncovering what learners know about number and how they use that knowledge to understand situations that call for proficiency in mathematics.

## Introduction

In the physical world humans come across situations in which their knowledge of different symbols, words, number and diagrams is put into practice so that they can look at and understand what they see. Gutstein (2003:41) refers to this practice as making sense of the world in which we live. To understand the physical, social and mental world implies that our proficiency in literacy and numeracy are essential tools that help us to make sense of new experiences. Recent suggestions regarding approaches to school mathematics place a high premium on the use of contexts and situations to develop mathematical concepts and procedures, contextually-driven justifications for conjectures obtained through inductive generalizations, to demonstrate and induct learners to the field of mathematical applications and modeling (Julie, 2006:49). This is because real life contexts are believed to be platforms on which learners can use their school-learned mathematics to understand real-life situations. But how often are real life contexts used to explore learners' understanding of numbers and number concepts? This question formed the central concern of the study. Learners were presented with an everyday situation based on which they were asked the following question: "what do you know about the number in the picture?"

## Design of the Study

The study involved 49 Grade 8 learners from a Middle School in a semi-rural Mafikeng, South Africa. The dynamics of the learning environment were characterized by varying intellectual abilities, varying learning styles, diverse cultural backgrounds and different socio-economic status of learners. These dynamics made the classroom a melting pot of all kinds of learning diversities. The aspect of socio-economic background is critical from Cooper's (1998:512) point of view. Cooper argues that the relationship between socio-economic status, culture and cognition is important since the use of certain items may lead to an underestimation of the mathematical capacities of children from different social backgrounds. The study therefore involved a diverse group of mathematics learners not only in terms of performance in Mathematics but also in thinking and learning

styles. An important aspect of the study's methodological approach concerned learners views and understanding of number when embedded in a real life context. Learners were presented with a real life situation in which they were expected to identify and explain in writing the mathematics which they thought was demonstrated in the scenario (see figure below).

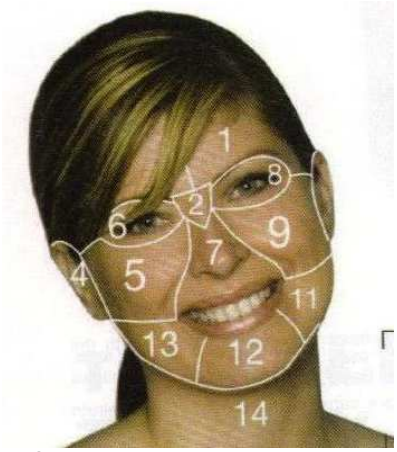



**Figure 1: The face scenario** (New Visions Magazine, vol. 22)

Why use a picture of a numbered face in particular? The National Curriculum Statement (NCS)

(Department of Education, 2003:7) places strong emphasis on the importance of selecting contexts inwhich learners can engage description of numbers, various representation of numbers, how different numbers can be thought about, and building learners number sense which is the foundation for further study in mathematics. It is further articulated in the curriculum that learners should use number sense and numeration to develop an understanding of the multiple use of numbers in the real world, to communicate mathematically and the use of number in the development of mathematical ideas (Department of Education, 2002: 11). The face scenario and the four questions that were based on the scenario were considered appropriate considering what is contained in the mathematics curriculum policy about reading, seeing, and writing mathematics at Grade 8 level. The study focused on four key issues namely, what mathematics learners saw in the scenario; what shaped the understanding of what they saw; how learners used their school-learned mathematics to understand what they saw, and lastly, what connections they made between the numbers that they chose and the specific part of the face in the scenario.

## Data analysis

The analysis of the qualitative data was in the three stages: (1) familiarisation and organisation, (2) coding and recording and (3) summarising and interpreting the data (Ary et.al, 2006:490). As Ary et. al (2006:490) recommends, qualitative data in this study was directly transcribed to avoid potential bias in interpretation that may come with summarising. The primary analysis technique was reading the data, that is, learners' written responses. This was necessary to familiarise the researcher with the data in order to get an overall idea of what it was offering. In general the researcher was looking for trends when grouping and summarising data. Views were then established and interpretable chunks of data across the four scenario questions were highlighted for analysis to see what issues characterised them. Some responses were unclear due to serious language difficulties. This was considered inevitable. In the analysis of learners' responses the researcher sought to identify what was the predominant view that learners held for the fourth question which was stated as: "why is that number on the picture?" Responses to this question formed the central part of the inquiry process as it was related to the use of numbers in this particular context (face scenario). An example of a typical response of learners to the fourth question was as follows:

> On the above picture I see a girl's face with many numbers on it. And I `ve noticed that there are numbers that are not there which are three and ten. When I look at the face I see mathematics and calculations. I see numbers which are like puzzles and there are shorting puzzles that has to be on the face or I would call it a face puzzle, cause its like a face puzzle with shorting puzzles (Learner L23).

## Results and observations

The first question which the study set out to answer was: *What mathematics do learners see in the scenario?* Grade 8 learners were able to identify numbers in the given scenario. Approximately two fifths of the sample was able to specify the different types of numbers that they saw. Learners mentioned concepts such as prime numbers, composite numbers, odd and even numbers. The nature of comments they made about the mathematics that they saw revealed that learners' responses were mainly at a surface level meaning that they were able to provide interpretations about numbers which one can say were anticipated. It became evident that what learners had acquired in their mathematics classroom had a significant influence on what they were seeing, because the mathematical concepts that they mentioned in their responses to the four question were acquired in the mathematics classroom. Learners' understanding of what they saw was shaped by what was already known to them. This was evidenced by the manner in which the observables were: (i) communicated (e.g. numbers were listed numerically), (ii) categorised (e.g. odd numbers were separated from even numbers), (iii) number concepts were mentioned (e.g. integers, odd numbers, even numbers, composite numbers and prime numbers) . This indicated that they were using their school-learned knowledge to make sense of what they were seeing. It also indicated that learners did not only see numbers but they were able to say something "deeper" about what they were looking at. All learners except one (L6) could only recognise the mathematics that was specific to Learning Outcome 1, i.e. number and number relationships. L6 took a geometric view of the picture when he associated picture with the concept of polygon. The concept polygon is specific to Learning Outcome 3 (Space & Shape) in the NCS (Department of Education, 2002)..

The second central question was: b) *How do learners explain in writing the purpose of numbers as they appear in the scenario*? The scenario provided learners with the opportunity to recognise the use of numbers in a realistic situation that was presented to them. Two learners made precise descriptions that were consistent with the philosophy behind "face mapping" in relation to the numbers that they chose. Face mapping has a background from from skin care processes (http://www.worldwideshoppingmall.co.uk/body-beauty). A total of 8 learners succeeded in identifying relationships between specific numbers and specific parts of the face. These learners explained that the numbers that they chose were there to identify specific parts of the face in the scenario. However, the scenario unveiled constraints of working with contexts to enhance the teaching and learning of mathematics related to number. This was evidenced by the difficulties encountered by 22 learners when they were asked to explain what the numbers they have chosen stand for in the picture. Although these learners were able to identify numbers from the scenario, they find it difficult to explain why the numbers are there.

The third question was: *What is the effectiveness of the scenario as a tool for exploring Grade 8 learners' knowledge and understanding of number*? The scenario served as a tool that uncovered learners' thinking about natural numbers. The scenario was an enabling tool for some learners while to others it could be considered a constraining tool. It was through the

scenario that learner's misconceptions, misinterpretations, poor assumptions about numbers, little understanding of natural numbers and rich connections were revealed. The scenario was therefore instrumental in revealing the learners' surface and deep understanding of number concepts. A key finding related to this study was the uncovering of a more comprehensive portrayal of the kinds of connections some learners (particularly L6 and L30) were able to make. Two of these responses are quoted below:

The scenario was an opportunity for learners to use their knowledge of number to interpret a part of reality presented to them. In conventional mathematics classrooms, learners' content knowledge related to number concepts is tested through the use of formal tasks which are later assessed quantitatively. Such tasks provide little opportunity for learners to express their knowledge of number for teachers to diagnose misconceptions, levels of understanding, contradictions and thick descriptions about learners' knowledge which are rich and pedagogically useful. As an educator who spent two years working with these learners, the scenario afforded me the opportunity to diagnose my learners' uncertainties in their knowledge and competency about number. Having spent two years teaching these learners it became clearer to me that the analysis of their responses to the scenario provided a framework of reference to begin to reflect on my own teaching and knowledge of number concepts. In particular it is critical to consider the notion of reading the world using mathematics. The fact that most of the learners could not explain why numbers are in the picture suggests that their knowledge of number is something that may have "divorced" from their everyday experiences. Learners encountered difficulties in transferring their knowledge of number to a different situation. This lack of transfer may be attributed to traditional mathematics practices which are textbook-bound and involve little integration across concepts in the mathematical domain. Taking into consideration these learners' responses to this activity, the scenario may be considered an effective tool to explore Grade 8 learners' understanding of the number concepts.

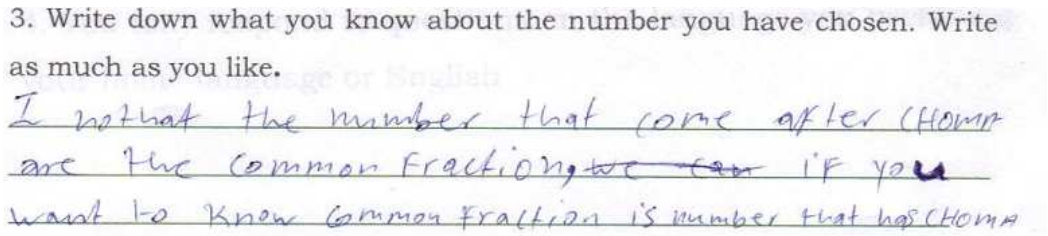
**Findings**

The analysis of the data revealed four important fings that pointed to the usefulness of context in the teaching of mathematics in relation to number concepts.

Finding 1 was related to the question: *What does the nature of comments reveal about learners' knowledge and understanding of number*? Kilpatrick, Swafford and Findell (2001:117) indicate that how learners represent and connect pieces of knowledge is a key factor in whether they will understand it deeply and can use it for problem solving. The degree of learners' conceptual understanding is related to the richness and extent of the connections they have made. This was evident in L6 and L30's responses. L6 and L30'S responses are (respectively ) to the second instrument question which was: Write down what you know about the number you have chosen.

> I like number 5 because it easy to multiply with and 5 is a prime number and odd number. 5 is half of 10 and ¼ of 20.
>
> I know that five is a natural and a prime number because the factors of five are 1,5. And that five can also be expressed as a hole number. And that -5 is smaller than 5.

These learners were able to provide multiple representations of number, insights on how the number 5 can be thought about e.g 5 is ¼ of 20 and it is half of 10. These two learners descriptions of what they know about number is a portrayal of mathematics as aliving body of knowledge. Their comments revealed some understanding of what they know about the number 5. This can also be seen in L12's response to the third question as follows:


3. Write down what you know about the number you have chosen. Write as much as you like.

I notnat the number that come after CHOMA are the common fraction, ~~we can~~ if you want to know common fraction is number that has CHOMA

Learners were requested to respond to the second question which was: "From the picture above choose the number you like and say why you like the number". Instead of choosing a number L12 listed all the numbers that he saw in the numbers that he saw in the scenario as it can be seen in his response below. What this learner said he knew about the numbers he rote was clearly a misconception. According to this learner when these numbers are placed behind each other with a decimal sign in between then they can be identified as common fraction

> 1,2,7,8,5,6,12,11,3,4,9,13,I like this number because the number that come after comma are the common fractions .

Finding 2 was as follows: Learners' responses unveiled possible constraints in representing in words what they saw. This phenomenon was attributed to language difficulties. It was clear that most learners encountered difficulties in communicating what they saw in the scenario. The instances of breakdown in communication were notable in learners' responses to questions. This was evidenced by the prevalence of spelling mistakes and direct translations that L1 made, for example. The difficulties were attributed to language inability to express in written form what the learner needed to communicate. Language is seen as a tool for communicating and thinking (Setati, 2005:94). Here the possibility of second language being a barrier to communication is explored.

*Finding 3:* Learners descriptions of what they saw in the scenario suggested that they had various interpretations of the same picture (face scenario). This was an indication that the picture appeared differently to these learners. L30 saw fractional divisions on the picture. In L22's view the lines on the face formed pieces, while to L15 the lines appeared to have formed blocks. L23 saw puzzles and that some puzzles were missing. L6 said that he saw polygons. L30 like L6 used mathematical concepts to interpret what he saw. A possible explanation for the diverse interpretations provided by these learners could be linked to the notion of "situation specificity" as articulated in Anderson, Reder and Simon (1996:6). From this perspective it acknowledged that learning is not wholly tied to a specific context, and mathematical competence is not always contextually bound. But what does this claim imply for this study? The concept of polygon, as it emerged in the analysis of L5's response for example, was learned in the mathematics classroom. It seems that this concept now became a tool that is available to this learner to make sense of what he is able to see in a different situation (the face scenario in this case). Similarly L30 who related the divisions in the face scenario with fractions, reminds us that what she learnt in the classroom about fractions was not tied to that classroom context. The following quotation by6 Cohen et al (2003:13) could help us better understand these learners varying perspectives and diverse interpretations of the same phenomenon.

> Concepts enable us to impose some sort of meaning on the world; through them reality is given sense, order and coherence. They are the means by which we are able to come to terms with our experiences. How we perceive the world then, is highly dependant on the repertoire of concepts we can command. The more we have the more sense data we can pick up and surer will be our perceptual and cognitive grasp of whatever is 'out there'. If our perceptions of the world are determined by the concepts available to us, it follows that people with differing sets of concepts will tend to view the 'same' objective reality differently.

Finding 4 was linked to the question: What is the reason for learners' choosing numbers but not indicating the reason for their appearance in the picture. Considering the learners (8) who made comments that are explicit about what they thought numbers represent in the picture, we are able to see that the use of contexts in mathematics is desirable. These learners used their mathematics school-learned knowledge to understand what they were seeing. So what does this mean to twenty two (22) learners who were unable to "see" the utility of numbers in the scenario? What does it suggest about the classroom practice to which these learners are adapted? Adler et al (2000:12) comment that there is no doubt that integration within mathematics is desirable but this approach will place new demands on teachers.

## Conclusion

The use of contexts to connect mathematics to the experiences of learners is desirable and more pronounced in the National Curriculum Statement. The face scenario which was used in this study exhibited certain key features of this approach. A critical examination of issues that emerged in the qualitative analysis of data in this study seems to suggest that, in the real world mathematics plays a completely different role. There is therefore a need to bridge gaps between school mathematics and mathematics in real life with an eye towards extending research in the direction of usage of number to express phenomena. The idea that knowledge is situated should be a point of departure. The study demonstrated that learners should be encouraged to view mathematics as an interesting, powerful tool that enables them to understand and express phenomena. This can be achieved through a suitable classroom practice.

## References


Adler, J., Pournara, C. & Graven, M. (2000) Integration within and across mathematics, *Pythagoras*, Vol. 53. pp. 2-13.

Anderson, J. R., Reder, L.M., & Simon, H.A. (1996) Situated Learning And Education, *Educational Researcher*, Vol. 25 (4) pp. 5-11.

Ary, D., Jacobs, L.C., Razavieh, A., & Sorensen, C. (2006) Introduction to research in education (7th edn) Thomson Wadsworth, Australia.

Cooper, B. (1998) Using Bernstein and Bourdieu to understand children's difficulties with "realistic" mathematics testing: an exploratory study. *Qualitative Studies in Education*, Vol.11 (4), 511-532.

Cohen, L. Manion, L. & Morrison, K. (2003) *Research Methods in Education* 5th Ed. London. RoutledgeFalmer

Department of Education (2002). *National Curriculum Statement – Mathematics R-9*. Department of Education, Pretoria.

Department of Education (2003). *Revised National Curriculum Statement – Mathematics R-9*. Department of Education, Pretoria.

Gutstein, E. (2003). Teaching and Learning Mathematics for Social Justice in an Urban, Latino School. *Journal for Research in Mathematics Education*, 34(1), 37–73.

Julie, C. (2006) Teachers' preferred contexts for Mathematical Literacy as possible initiators for Mathematics for Action. *African Journal of Research in SMT Education*, 10(2) 49-58.

Kilpatrick, J., Swafford,. & Findell, B. (2001) (Eds) *Adding it Up: Helping Children Learn Mathematics*. National Academy Press. Washington.

Setati, M. (2005) Mathematics Education and language policy, research and practice. In Vithal, M., Adler, J., and Keitel, C. (eds) Researching Mathematics Education in South Africa. HSRC, South Africa