Approaches to Teaching Mathematical Computations: What Foundation Phase Teachers do!

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Abstract

This investigation emanates from the realisation that grade three children at schools in disadvantaged areas perform poorly in basic mathematics computations such as addition, subtraction, multiplication and division. The aim of the research was to establish the approaches teachers use when teaching mathematics computation. The qualitative approach, together with the research techniques commonly used with it, namely observation, interviews and document analysis were deemed appropriate for the investigation. The outcomes of the investigation revealed that the multilingual grade three classes made it difficult to assist all children who experienced mathematics problems because teachers could not speak all the other languages that were not the language of learning and teaching (LoLT) of the school. Another obstacle that prohibited teachers from spending adequate time with children with mathematics problems was the time teachers were expected to spend on intervention programmes from the Department of Basic Education (DBE) aimed at improving schooling in general. Teachers could not make additional time that could afford children the opportunity of individual attention. With regard to the approach used for teaching mathematics, this study established that the teachers used the whole class teaching approach which is not a recommended approach because each child learns differently. It is recommended that teachers use a variety of teaching methods in order to accommodate all children and also encourage children to use concrete objects.

Keywords: *mathematics, mathematical difficulties, Foundation Phase, Mathematical knowledge*

1. Introduction

There has been a growing recognition of the importance of the early years for the acquisition of mathematical skills in South Africa. The realisation that a strong foundation is needed if children are to be successful in learning mathematics at higher grades prompted the Department of Basic Education (DBE) to conduct systematic evaluations in mathematic competency at primary schools. Although the poor outcome of the DBE's Annual Mathematics Assessment in 2012 was symptomatic of dissatisfactory performance levels in the foundation phase, research at this level remains scant and indicated good mathematical skills later in the school in numerous studies (Department of Basic Education, (2012:3).

Numerous studies in mathematics (Fricke, Horak& Meyer, 2008; Le Roux 2008; Themane, Monyeki, Nthangeni, Kemper & Twisk 2003) have been conducted in South Africa but the focus has always been on secondary schools. Often the investigations concentrated on classroom variables such as teaching resources and textbooks that could influence performance but not on teacher attributes that could impact negatively on successful learning. The contention is that the cumulative effect of this oversight can compound into serious mathematics learning problems at higher grades and needs to be addressed early in the child's schooling. It is also important to pay attention to specific difficulties experienced in teaching or learning mathematics in order to propose effective solutions to the problems.

This study emanates from the recognition of problems in the teaching and learning of mathematics in grade three classes of some schools at disadvantaged areas of the Tshwane South District. The particular problem noted is the children's inability to perform basic operations in mathematics. They lack the ability to perform computations such as additions, subtractions, multiplications and divisions. The concern is if the problems are not addressed in the foundation phase it might be too late to deal with them in the higher school grades. In fact it is known that the performance in mathematics at grade twelve is poor as seen from the TIMMS results (DBE, 2012).

With regard to problems in addition operations, a significant number of children are unable to carry units over to tens and tens to hundreds. An example of the error they commit is illustrated below:

247 + 165 = 302.

The error is a reflection of the children's inability to carry over from the units to the tens. The child correctly add 7 + 5 to get 12 but fail to carry 1(ten) over to the tens. This explains why in the tens the answer is 0 and not 1. The child add 4 + 6 to get 10 (with a loss of 1[ten] from the units). The child also fails to carry from the tens to the hundreds. The addition 2 + 1 = 3 is not wrong but it is not the correct answer because the children do not carry to the hundreds.

The correct answer to the above computation is as follows:

247 + 165 = 412

The aim of this research is therefore to identify approaches teachers use when teaching mathematics computation. In other words, to explore how teachers resolve children's challenges in mathematics computations, and how teachers identify children who experience difficulties in mathematics. It also aims to explore which aspects were more problematic in the teaching and learning of computations, and what more do teachers do to help children understand mathematics computations.

2. Literature Review

The research aims to establish the approaches teachers use, other difficulties teachers experience and which aspect of mathematics is most problematic when teaching mathematics computations. It also aims to establish how teachers resolve the problem with the aim of developing a support programme for foundation phase teachers.

2.1 The mathematics skills approach

The skills approach focuses on memorisation of basic skills (Baroody, 2003:17). This approach is based on the assumption that numerical knowledge is simply a collection of useful information (i.e. facts, rules, formulas and procedures). In the skills approach, a teacher simply tells children that, for instance, to add addends you start adding from the units, tens, hundreds and so on. Children then complete numerous computations with the procedure until it is memorised by rote.

As practice is performed without context (a reason) at a largely symbolic (abstract) level, the skills approach is not purposeful (in the sense that instruction builds on children's interests and creates a genuine need to learn and practice mathematics), nor is it typically meaningful. As children are seldom engaged in any real numerical thinking, the skills approach is almost never inquiry based, as it involves a repetitive practice.

Even though the foregoing discussion asserts that the skills approach focuses on memorisation, it is important that foundation phase teachers encourage the children to learn the multiplication tables in order for them to apply the knowledge when completing mathematics tasks. Schoenfeld (2004:280-281) argues that in mathematics, an exclusive focus on basics leaves children without the understanding that enables them to use mathematics effectively. A focus on "process" without attention to skills deprives children of the tools they need for fluid, competent performance.

2.2 The mathematics conceptual approach

Baroody (2003:17) argues that the focus of the conceptual approach is on the meaningful memorisation of skills. This approach is based on the assumption that mathematics constitutes a network of skills and concepts. Children are viewed as capable of understanding mathematics if told or showed why procedures work. The aim of this approach is for teachers to help children to acquire needed facts, rules, formulas, and procedures in a meaningful way (i.e. with comprehension). The teacher guides children towards understanding and mastering skills.

In the conceptual approach, symbolic procedures, such as addition of addends are illustrated by actual teacher demonstration. Children may even be encouraged to imitate an illustrated programme themselves with manipulative. Thus, although instruction and practice is often without context, an effort is made to promote meaningful learning.

From the discussion above, it is important that foundation phase teachers should guide children towards understanding and mastering skills. Teachers should provide them with tasks/activities that will help them to acquire those skills. Children would then be able to solve problems themselves.

2.3 The mathematics problem-solving approach

The problem-solving approach focuses on developing numerical thinking (i.e. reasoning and problem solving). This approach is based on the assumption that mathematics is, at heart, a way of thinking, a process of inquiry, or a search for patterns in order to solve problems. Children are viewed on the one hand, as using intuitive thinking and possessing incomplete knowledge; and on the other hand, as naturally curious creatures that can and must actively construct their own understanding of mathematics. The aim of mathematics instruction is to immerse numerical novices in mathematics inquiry (solving what are to them real and challenging problems) so that children can develop more mature ways of thinking and incidentally discover and construct more complete mathematics knowledge.

The teacher as a wise partner in this enquiry pushes the process along but does not entirely, or even largely, set the agenda or control the enquiry. The learning content such as the formal procedure for addition in word sums, is secondary to developing children's thinking processes (Baroody, 2003:17).

In the light of the discussion above, it is clear that learning by using this approach will encourage children to construct their own understanding of mathematics. It will also enable children to investigate and to solve real and challenging problems that they may come across.

2.4 The mathematics investigative approach

According to Baroody (2003:17), the investigative approach focuses on meaningful memorisation of skills and development of numerical thinking. Like the conceptual approach, mathematics is viewed as a network of skills and concepts. Also, like the problem-solving approach, it is viewed as a process of inquiry. Children's active construction of understanding is mediated, guided and prompted by the teacher – most often through planned activities. In the investigative approach, the teacher mentors children guiding their meaningful construction of procedures and concepts, and the development of numerical thinking. The teacher uses indirect means to help children to construct knowledge. For example, a teacher might guide children to reinvent a procedure such as the algorithm for addition of word sums. The teacher might then encourage children to invent their own procedures for solving the problem. That may well involve using manipulative or drawings.

2.5 Mathematics: the enjoyable way

De Corte (2004:280) claims that "Mathematics is no longer mainly conceived as a collection of abstract concepts and procedural skills to be mastered, but primarily as a set of human sense making and problem-solving activities based on numerical modelling of reality". Indeed children should learn by understanding and not by rote. In order to understand mathematics, the teaching of concepts through everyday language and the use of the immediate environment is critical and essential. The old method of making children learn by rote, passively and with repetition, is no longer encouraged in the reformed curriculum. Teachers who still follow this approach are themselves a barrier to teaching mathematics, which further compounds children's problems. Such educators should be retrained in order to help them to help and support the children they teach.

Fagnant (2005:355) alleges that in mathematics, different from other sciences, objects don't have a tangible existence. In other words, mathematics can only be presented symbolically. However, in mathematics classes, teachers use counters to develop children's skills of adding and subtracting. It is precisely this symbolic representation that needs clear and simple language together with examples from the children's immediate milieu to understand mathematics.

The role of the teacher in this regard is of vital importance. Attention should not, therefore, be focused on the symbols and their meaning, but rather on the symbolising activity and meaning making (Cobb, Yackel & McClain, 2001). Therefore, the teacher who lacks language or skills to impart knowledge will be a barrier to children. The situation becomes even direr where the medium of instruction is a second language. This is a major impediment for South African children and therefore strategies should be devised to improve mathematics teaching.

3. Research Methodology

The qualitative approach was used in this study to explore the views of grade three teachers regarding the approaches they use in teaching and learning of mathematics computation. We opted for this approach as it allows researchers to gain insight into the inner experience of participants, to determine how meanings are formed through culture, and to

discover rather than test variables (White, 2005:81; Corbin & Strauss, 2008:12). To collect data we used semi- structured interview as it helped to explain in detail what approaches teachers use when they teach computations in mathematics. For the purpose of this paper, we interviewed and observed five teachers from five different schools. The interviews were held during school time and lasted approximately 1-1½ minutes. We conducted individual face-to-face interviews and did the observations with all the five teachers.

4. Findings and Discussions

4.1 Approaches used in the teaching of mathematics computation

We first asked the teachers what teaching approaches they used in the teaching and learning of mathematics computation. This we did in order to find out what teaching approaches were being used by the teachers, to establish whether the strategies were appropriate, effective, clear to the children, or if they led to children experiencing problems and hence poor performances. The responses that teachers gave did not refer to any specific approaches to mathematics teaching. Teachers also explained that they were obliged to implement other mathematics programmes.

All teachers explained that they were using the Foundations for Learning Campaign (FFLC). This FFLC is mainly an intervention strategy that the Department of Basic Education (DBE) developed to address mathematics problems in general. However, there were other programmes that they were required to implement. For example, the intervention programme was intended for non–functional schools that were part of the Gauteng Province Literacy Mathematics Strategy (GPLMS), and the Annual National Assessment (ANA) which is a compulsory examination for all grade three children at schools in the country. At the time of our collection of data the teachers were also allegedly still undergoing training for CAPS that was to be used in 2012.

4.2 Teachers resolving the problems

In order to determine what the teachers do in an effort to solve the problems they encounter in the teaching and learning of mathematics computation, we asked teachers what they do when meeting with the children with mathematics learning difficulties. The intention was also to establish whether the intervention was able to improve the children's understanding or not.

The response from teachers was that children with mathematics learning difficulties were assisted by being given extra activities to do after school. The teachers also indicated that they provide these children with easier problems to solve or give them examples from the previous grade (grade 2). This implies actually that they are lowering the learning standard or indirectly postponing grade three work and the problem.

Parents are also called in to the school and asked to help the children at home with their school work, but this request is rarely acceded to as alleged by the teachers. Those with easily identifiable defects like sight and hearing are referred to specialists such as opticians.

Children who still cannot perform as expected are referred to the school's school based support team (SBST) for further assistance. The irony of this is that some of the members of the SBST are not even experienced in teaching mathematics at grade three themselves. If the SBST also fails to remedy the problem, the school then invites a specialist from the district office to intervene and in this way the problem is recognised as being beyond the school to solve.

4.3 Teachers' identification of children experiencing mathematics difficulties

In this study, researchers had to explore what methods the teachers used to identify children who experience problems in learning mathematics. Therefore, we asked teachers how they actually identify these children during the teaching and learning of mathematics. This was also to ascertain whether those teachers' methods are effective or not.

The teachers claimed that they identify the latter through their (children's) performances in class tasks and tests. They also asserted that they would also identify poor performing pupils by asking oral questions; those not responding would be deemed to be experiencing problems. Report cards from the previous grade (grade two) teacher were said to indicate children with problems. Some children, it is averred, were identifiable by their failure to participate in group discussions.

Teachers were asked how they identify children who experience mathematics difficulties. This question was intended to determine whether teachers were able to identify such learners and the methods they use in so doing.

Effective identification would result in help being given to such children, on the one hand. However, on the other hand lack of identification may result in difficulties not being attended to. This is how one of the teachers responded: , TA indicated that at the beginning of the year of all children who experience Mathematics/learning difficulties' support forms observation books are given to the next grade teacher, whereby the previous teacher indicates the following information:

- date and what she observed in the child
- why she thinks that it's a problem
- when she observes that the problem persists she puts that in the 450 form and took the matter to the HOD and the matter will be forwarded to the district officials who deal with intervention.

TA further indicated that some children have difficulty in confusing 21 and 12, 82 and 28 when see this in Grade 3 it tells you that the child has a problem. After the matter has been forwarded to district officials and there is no support that they can provide to the children, they refer the child to specialists for example a psychologist or eye specialist

All participants agreed that children are identified through tests and failure to respond/give feedback. A minority indicated that they used observation books from the previous Grade. Very few participants said that they could identify children through failure to answer questions orally. A minority said they identified children through mental work and different strategies.

4.4 Problematic aspects in the teaching and learning of mathematics

In order to establish whether there were any specific aspects that were most problematic from a teaching point of view or from understanding by pupils, we asked the teachers which aspects of mathematics computation were most problematic. We also wanted to determine if the problems were general or differed from one school to the other, from teacher to teacher or were related to any difficulty in the syllabus. This would establish whether individual teachers' methods were the cause of the problem and needed attention.

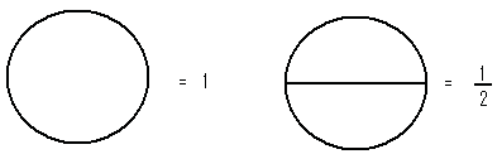
The response from teachers did not identify a mathematical aspect per se, because they referred to the language of teaching and learning (LoLT) The teachers pointed to a number of factors in this regard. Learners at these schools came from different ethnic groups and hence spoke different home languages that teachers did not understand. This was further compounded by the presence of children from foreign countries who spoke languages that the teachers themselves knew nothing of. Mathematical concepts were also difficult to teach in African languages; for instance the four basic operations (addition [to a lesser extent], subtraction, multiplication (carrying over) and division (remainder). It was difficult for teachers to coin new words. Even then only a section of the class would benefit.

4.5 Lessons observed

We also had an opportunity to observe a number of lessons where different teachers taught different topics as discussed below.

One of the topics we observed was multiplication.The teacher began by explaining the term "multiplication" to the children. She explained that multiplication is similar to addition. She gave the example of $3 \times 3 = 9$ as being similar to $3 + 3 + 3 = 9$. However, some children then interpreted this (3×3) as being the same as $(3 + 3)$. This led to further confusion as the children also became confused as to which symbol or operation, × or +, meant multiply or add. The teacher attempted to simplify the children's understanding of multiplication by referring to addition but confused the children. This implies that the children identified as experiencing difficulties in mathematics (multiplication) sometimes do not really have those difficulties but that the teachers' teaching approaches or the instructions given could contribute to these difficulties.

We also observed a halving lesson in which children were asked what they know about fractions. The teacher gave children a clue by giving the example of a mother who possesses one orange and has to share that between two children. How would she do so? Some children answered that each child should get half; others answered that the orange should be cut in the middle.



The challenge we observed during this lesson was that children encountered difficulty with mathematical concepts as the books were written in English whereas in the school children are taught using the LOLT of the school. For example, the fraction given above in English is called halve whereas in Northern Sotho the term is *seripa gare*. Children who are not Northern Sotho speakers will not understand or even take part during the teaching and learning process. This implies that some children know the concept "half" in theory although they do not know it practically. Those who knew the concept "half" theoretically would understand better when it is shown to them practically but those who did not know it would find it difficult to understand both the theory and the practice.

The other lesson we observed was multiplication. We observed a multiplication lesson in which the teacher was teaching children how to multiply. The teacher brought concrete objects and demonstrated how this can be done, for example: 24 × 3=

The teacher explained to the children that 24 × 3 means 24 thrice. She further showed children how to solve the problem, for example:

24 × 3
(20 × 3) + (4 × 3)
60 + 12
(60 + 10) + 2
72

A lot of children did not understand how the teacher arrived at the answer. Some children confused the multiplication sign with the addition sign, for example 24 × 3= 27 whereas other children were unable to carry over to the tens, for example 24 × 3= 60. This implied that children understand better when using or seeing concrete objects.

A lesson on word sums was also observed. The teacher introduced the lesson by asking the children how many pens they would be left with if they each possessed nine pens and were asked to give three to their friends. A number of different answers were given. The teacher then grouped the children into pairs, gave them nine marbles and asked them to give their partners three and tell the class how many were left. It seemed easy for the children to execute the task, but when the teacher used the concept of the basic operations (minus), most of the children failed to understand. The impression is that the difficulty in doing word sums lies in the lack of understanding the concepts. Learners understand only if one asks, "From nine pens give your friend three; how many are you left with?" but once the teacher says "nine minus three", it becomes something different.

One more lesson observed was expanded notation. The teacher showed the children a musical instrument called the accordion and demonstrated how it is played. They initially saw it as a small instrument but as the teacher played it became longer. Then the teacher told children that even numbers can be expanded. She wrote the number 46 on the chalkboard, and asked one child to read that number out. She asked the children what the number 46 is made of. She explained to the children that 46 have two digits meaning four and a six and the digits are not equal in value. She further explained that the value of the six units is one whereas the value of the single unit is a ten. She asked the children "how many units do we have and how many tens do we have? When expanding the number 46 this is how we write it: 40 + 6 = 46". The teacher worked through more examples with the children and they were actively involved and understood what was taught. This implies that when the teacher's instructions are clear, children tend to understand.

A lesson on number names was also observed. The teacher requested all the children to go outside (to the car park). She asked each child to write down any number that was on the car number plate. Then children were instructed to go back to the classroom. In the classroom they were given the following instructions: "Add five to the number you have written down and write down the number's name, for example: 114 + 5 = 119 (number's name is hundred and nineteen). Add three to the new answer and write down the number's name, for example: 119 +3 = 122 (number's name is hundred and twenty two)". It was an interesting lesson, during which some children were able to carry out instructions from the teacher but many others showed that they were unable to write down the number names. The teacher arranged them in groups and repeated the same instructions after which the performances were better. This implies that when children work together they learn from each other and they are not afraid to make mistakes.

5. Conclusion

Mathematics teaching was dominated by the teacher and very little interaction with children took place. Teachers were not aware that other children did not understand. The large numbers in some of the classes prohibited the teacher from noting some children's questioning gaze that could have alerted her to the fact that those children did not understand what she was saying. A poor teacher-child interaction could be regarded as a contributory factor to some of the problems

experienced by the children in the same manner.

Individual attention promotes learning on the part of children. The fact that child-to-child interaction yields better understanding among children is a useful way of promoting learning. Therefore, it could be concluded that when there is no individual attention the outcome is poor performance.

From the data collected through interviews, we conclude that the fact that teachers did not explain how they solve children's problems, but instead referred to the language of learning as a problem, emphasises the severity of this issue. It seems to them that language ability is an important contributory factor to successful learning. It might therefore be necessary to consider the influence of language in mathematics teaching.

With regard to the identification of children who experience mathematics difficulties, it became evident that the methods the teachers used could be problematic themselves. For instance, teachers who concluded that these children who did not participate during the lesson were encountering mathematics challenges could be wrong because such children could be struggling with the language of teaching and not mathematics per se. Since no standard identifying criteria are given to teachers of such children, it will be prudent to consider the teachers' expertise in mathematics teaching, the child's language and the curriculum content.

Finally, in order to address the problems identified in this study, we conclude with the following recommendations. Firstly, to address the issue of teaching approaches, it is important that teachers use a variety of teaching methods in order to accommodate all children and also encourage children to use concrete objects. Secondly, children's challenges in mathematics computations could be addressed by selecting SBST members who have a mathematics background and who are trained to do remedial work. Most SBSTs do not consist of members who are qualified to act in this capacity. In many schools the SBST is made up of the principal and other members of the school management team (SMT) who do not necessarily possess expertise in supporting children who experience difficulties in mathematics but are included in the SBST by virtue of their seniority in the schools. Lastly, assistant teachers involved in the SBSTs should consist only of members qualified in the subject, and knowledgeable about supportive measures that can improve children's abilities.

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