



# EXPLORING INSTRUCTIONAL STRATEGIES THAT ENHANCE PROBLEM SOLVING SKILLS IN MATHEMATICS GRADE 3

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**ABSTRACT**– The current transformation of the curriculum in Gauteng Province is based on a plan to improve languages and mathematics due to the poor performance of learners in general and most especially in the Annual National Assessment (ANA). Among the strategies put in place by the Department of Education to address the low performance and the poor results in mathematics and languages was the introduction of the Gauteng Primary Language and Mathematics Strategies (GPLMS). One of the objectives of the GPLMS was enhancement of effective problem solving instructions in mathematics among teachers at primary schools. The aim of this study is to engage in a descriptive analysis of the performance of Grade 3 learners at a Primary school in Ekurhuleni North District as regards to problem solving and how teachers in Grade 3 engage with learners at problem solving tasks. The findings of descriptive analyses show that on overall the teachers are still grappling with problem solving strategies and how to instruct in ways that enhance learners’ problem solving skills in mathematics. The learners are still rooted in procedural methods of solving problems and seem to lack the conceptual understanding that is critical in problem solving.

**Keywords:** Primary mathematics, Problem solving, teaching and learning mathematics

## 1. INTRODUCTION

Both international and national studies point to the fact that South African learners in the primary schools are among the lowest performers in mathematics and science (TIMMS 2011). In the South African context the Annual National Assessment (ANA) are meant to investigate and inform the learners, teachers and parents on areas of knowledge that requires support and guidance. In the 2011-2014 ANA results (ANA: 2011-2014) learners at “South Primary” school, (fiction name) had a particularly low performance on questions involving problem solving. At this school one of the strategies put into place by the Department of Education to address the low performance in mathematics and languages was the introduction of Gauteng Primary Languages and Mathematics Strategies (GPLMS). One of the objectives of the (GPLMS) is enhancement of effective problem solving instructions in mathematics among teachers at primary schools.

Problem solving in the area of mathematics is described in various ways in the literature. Bennet and Nelson (1998:3) define problem solving as a process that encourages resolving of unfamiliar situations while Luneta (2013:115) defines problem solving as the ability to use one’s mental processes to interact and resolve problems as well as make reliable judgments on the credibility of a claim or desirability of a course of action taken to resolve a problem. In this study I draw on Polya’s (1945:87) framework of problem solving involving the following steps:

- Understand the problem-how well do teachers instruct learners to understand a problem before attempting to answer it?
- Develop a strategy – how do teachers instruct learners to develop a strategy to solve a problem?

- Execute the strategy- how do teachers instruct learners to actually solve a problem?
- Review the solution- instructionally how do learners ensure that their answers to problems are correct?

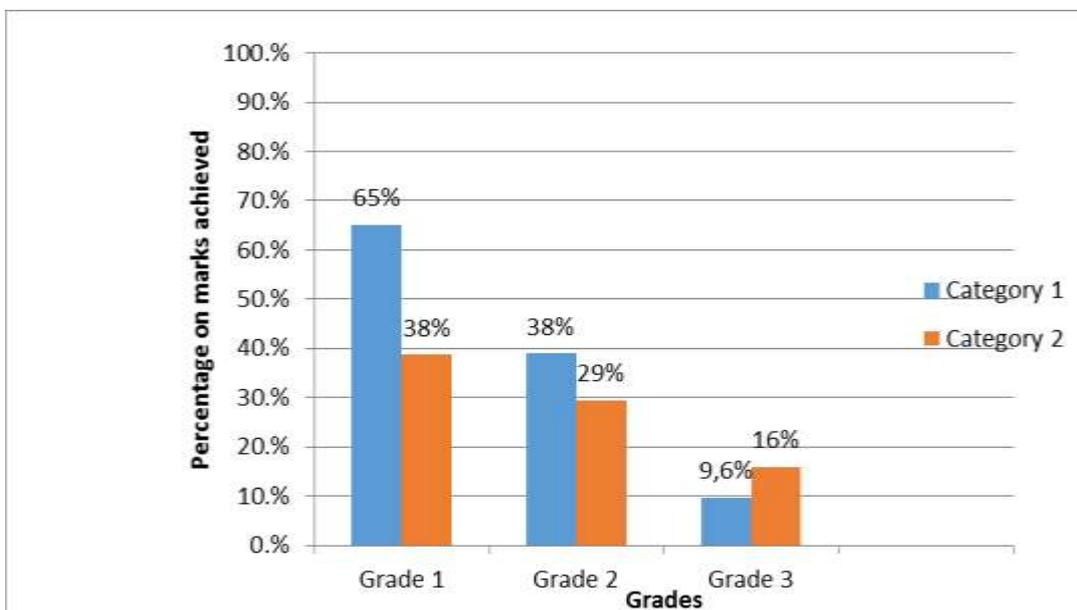
Luneta (2013:7) explains that teachers’ different knowledge bases (pedagogical knowledge, content knowledge, pedagogical content knowledge (PCK) conceptual and procedural knowledge) are critical to effective teaching of mathematics. In addition Shulman (1986) maintains that teacher PCK and understanding of specific topics is essential for effective teaching and learning. In addressing the issue of problem solving by learners in Grade 3, I therefore argue that the improved performance of learners is directly tied to effective teaching by their teacher and one key measure to judge the effectiveness of teaching is through the performance of learners. Thus the knowledge learners acquire is directly related to the pedagogical content knowledge and other knowledge of mathematics strategies and techniques that teachers display when teaching problem solving skills.

Moodley, Njisane and Presmeg (1992:26) note the significant influence of teacher knowledge on the teaching methods they use in class. This implies that effectiveness of teaching depends on the type of knowledge teachers possess. In the context of Gauteng Province there is no research on how improvement strategies, such as GPLMS, enhance the teaching of problem solving in Grade3 mathematics. This study addressed this gap as I investigated how teachers instruct learners to use the problem- solving strategies included in the GPLMS.

## 2. STATEMENT OF THE PROBLEM

The Culture of Learning and Teaching (COLT) is not effective at South primary school due to the poor performance of learners in mathematics which has been related to the instructions they receive from teachers at that level. The result of Annual National Assessment (ANA) 2014 is evident to this report. South primary is one of the schools that has being regarded as dysfunctional by the Gauteng Department of Education (GDE) because of the high number of retained learners and also on the poor performance of learners in Grade 3 and 6 on (ANA). We therefore intended to investigate the success of the GPLMS programme in terms of the strategies which educators are using when teaching problem solving in Grade 1-3, due to the ongoing poor performance of learners in mathematics particularly on problem solving.

**Table 1. (Show the analysis of ANA result (2012) on question 7 and 8 for Grade 1 & 3 question 12 & 16 for Grade2) South Primary School.**





**Category 1:** shows results on questions 7, and **Category 2** shows results on question 8. (**Solves money problems, solves and explain solutions to practical problems that involve equal sharing and grouping**). Grade 1 achieved 65% on question 7, & Grade 3 9.6% Grade 1 achieved 38.7% on question 8, & Grade 3 achieved 16%. Grade 2 achieved 38.97% for question 12, and 29.41% for question 16.

The summary of (ANA) 2012 results depicted on the graph above is eminent to the statement problem of this study which addresses the poor performance of learners on (ANA) in regard with solving mathematical problems.

The aim of this study is to:

- Explore the strategies employed by the teachers at South Primary when implementing GPLMS when teaching problem solving in Grade 3.

**The research question is:**

*How do the instructional strategies developed by GPLMS enhance the teaching of mathematical problem solving to Grade 3 pupils?*

Sub- questions:

- *What are teachers' strategies for teaching problem solving and how do these strategies address problem- solving in Grade 3?*
- *How do Grade 3 learners experience the problem solving strategies used by their teachers?*

The objectives of this study are to:

- Investigate whether strategies and approaches implemented by teachers when introducing problem solving are enacted as envisaged by Polya.
- Explore how Grade 3 learners experience the problem solving strategies used by their teachers?

### **3. RESEARCH METHODOLOGY**

This study can be classified as a generic qualitative study that will use qualitative methods of data collection and analysis Maree (2010). A qualitative mode of enquiry enabled me to explore the experiences, opinions and attitudes of learners and teachers when tackling problem solving. Data was collected through in-depth interviews with teachers as well as observation of their problem solving strategies. I also interviewed learners in order to establish, how they interpret instructions from their teachers and the support of their engagement with problem solving.

This study used stratified purposive sampling because I selected participants according to pre-selected criteria (Maree 2010). 18 learners and 3 teachers from South Primary were selected. The learners were selected and placed in three categories based on their abilities: 6 high achievers, 6 moderate and 6 low achievers in reference to their mathematics outcomes (based on averages in the various tests they have administered for mathematics in the classroom situation) I collected 18 learners' Annual National Assessment scripts and analysed their problem solving tasks.

I used the model designed by Maxwell in showing how the research question and goal of my study related. The model reveals that the relationship amongst components is conceptualized and that the different parts of a design form an integrated whole, as they are all connected to each other. I used the five components in explaining the interactive relation that is within the research question, conceptual framework, goals, methods and validity (Maxwell 2013:3).

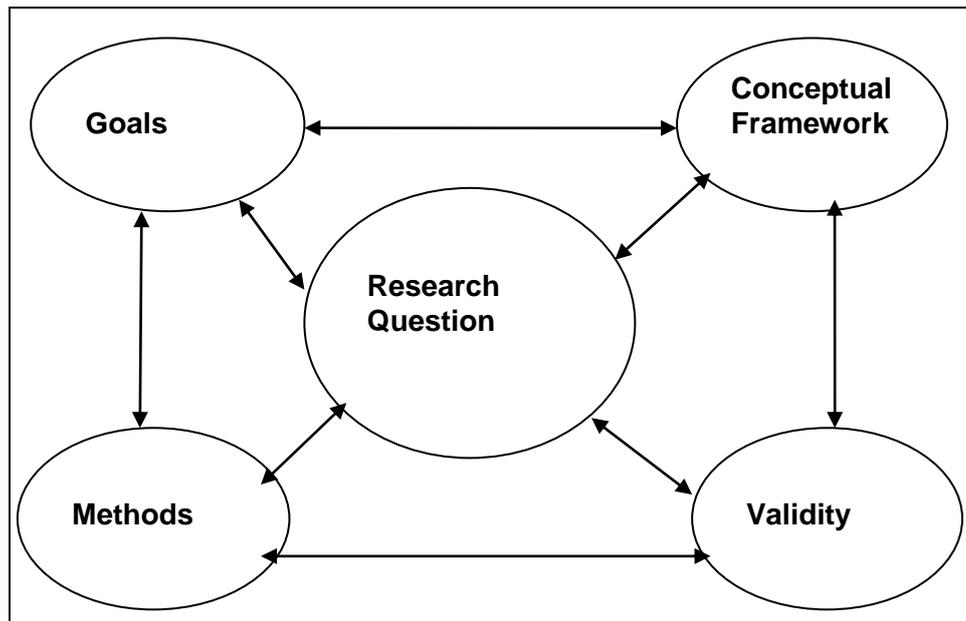


Fig 1 *Qualitative Research Design, an Interactive Model of Research Design* Adapted from Maxwell (2013).

In showing how the components of the research relate to each other as they all connect to the research question we determined how the problem formulated incorporated both research purpose and the identification of the unit of analysis. In this study the problem formulated is based on the continuous poor performance of learners despite the many enrichment programmes that teachers undergo in Gauteng, on improving their teaching skills in mathematics.

In following Maxwell's (2013) model of research design we placed the research question in the middle so as to enable us to show the relationship that exist between the question and the other elements of the research. Mouton (1996:101) posits that the researchers' background knowledge of the topic they wish to investigate will help them in determining factors that determine research goals. We therefore used the background of our research topic which is based on investigating improvement in the performance of Grade 3 learners when handling problem solving activities in mathematics and the strategies which the teachers apply when implementing GPLMS. The state of existing knowledge on the phenomenon to be researched is the major factor in deciding on the specific goals of the research study (Mouton1996:102).

The goals of the study were directed at addressing strategies applied by teachers when implementing (GPLMS), they determine improvement in performance of learners when tackling problem solving and exploring on different sustainable developmental programmes based on improvement of cognitive, cultural, and technological structure for attainment of enriched goals on teaching and learning mathematics. These goals are related to the research question, they both explore on the performance of learners and the strategies of teachers in regard with attainment of improvement in performance of learners.

**Comprehensive Framework:**

The framework explains the key factors of the study, the variables and the ventured relationship amongst them (Miles and Huberman 1994:18). It also attempts to interrogate the qualification of teachers affected in teaching mathematics and the appropriate classification of teachers in the Grades they're engaged in, their knowledge and skills. There is also an attempt to view the attitudes and actions of teachers and learners as regards problem solving. An attempt is also made to

understand the background of learners in terms of the parental involvement, and support they get from home in regard with their studies.

Figure 2 provides a conceptual schema for distinguishing between the inputs e.g. (teacher quality), processes indicator (teaching quality) also between outputs (achievements) and processes (instructional quality). The research question of this study enabled us to explore the quality of teaching in terms of the adequate strategies which enhance problem solving skills.

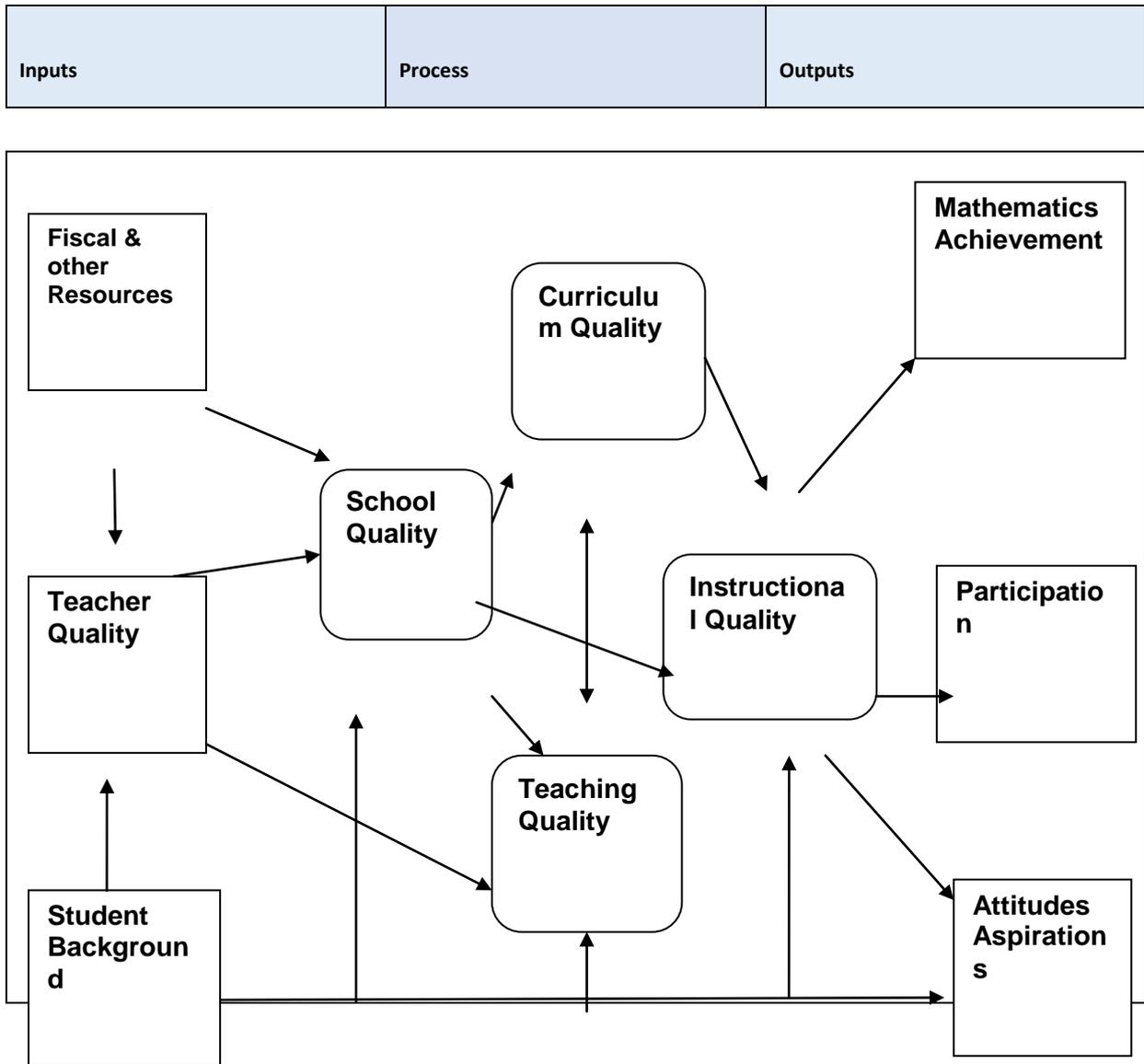


FIGURE 2 *Comprehensive Model Adapted from Shavelson, McDonnell and Oakes (1987)*

This model was developed from extensive literature review to illustrate the linkages between the social and the educational indicators related to the educational outcome. The three prime components of the education perspectives are “inputs”, “processes,” and “outputs”, in this research they were integrated within a context of teaching and learning.

The inputs are regarded as human and financial resources needed to sustain the process of teaching and learning, process refers to the integrated activities that create the educational environment, and outputs are the end product, the consequences of teaching and learning. We attempt to explain the findings in relation to the responses made to the research question, and the problem statement of

this study. The research question is depicted as follows: “How does the GPLMS enhance the teaching of problem solving in Grade 3”.

The achievements of learners on questions pertaining problem solving from (ANA 2014) were administered in determining the effectiveness of teachers strategies and skills used when teaching problem solving also the teachers instructional practices were administered through monitoring the type of questions they asked learners in class work exercises and home work as well as the methods which they applied when teaching problem-solving lessons. In true qualitative data analysis styles, the data was analysed inductively by interpreting what the data implied as we collected from the learners and the teachers by providing transcriptions of interviews, learners work and observations (Bernard and Ryan 2010:4).The results of the interview from teachers are also provided by showing comparative analysis of their contextual understanding of problem solving in mathematics.

An instrument was developed to analyse learners’ responses on problem solving questions. We observed the three teachers’ ability to address the teaching of problem solving tasks in class as determined from the work of Polya (1945). According to (Merriam 2002:5) qualitative research is based on process, meaning and understanding that the researcher is the primary instrument of data collection. We analysed and describe teachers’ present lessons on problem solving and triangulated that with the interviews and learners responses and ANA scripts. We also used field notes to capture our observations as teachers taught and learners solved problems.

We used content analysis to analyse our interviews, observation and communications involved in teachers teaching approaches (i.e. how they address problem solving), and learners’ scripts (i.e. their answers to ANA problem solving questions). We identified common ideas and patterns as we measured words in written form from interview transcripts, in order to find meaning, similarities and differences in responses. Henning, Gravett and Van Rensburg (2005) describe data analysis as the process transcribing and coding themes that emerge from categories. We used pre-determined categories of problem solving as described above by Polya and it is from these categories that we developed themes and eventually patterns to explain the extent at which the teachers’ engagement with GPLMS enhances problem solving in Grade 3.

Validation of qualitative research is the ability to relate the research findings to real life meaning and provide inferences from natural settings. This study attempted to do so by ensuring it was authentic and related to actual teachers and learners in natural and real setting and the information was made up of their views, practices and experiences in mathematical problem solving.

We have also showed how we analysed my data using coding where we searched for patterns and categorised them referring to differences and commonality. When one reads through transcribed data, going through line by line and dividing data into meaningful units that is the process of coding (Maree 2010). Coding refers to linking of data to ideas and vice versa, through a cyclical acts (Saldana, 2009:9).

*“when codes are applied and reapplied to qualitative data, you are  
Codifying”*

Saldana (2009:9).

We have shown how we codified and categorised data from the transcript below.

#### **4. FINDINGIND AND DISCUSSION**

Below we discuss the results by analysing learners’ class work and question on problem-solving from ANA (2014). The class work activities given to learners in this study were aimed at showing the understanding of learners in particular mathematical topics based on problem solving and how they interpreted information from the National Assessments activities. Class Work 1 was based on solving



money problems, second class work was on fractions, third class work on word problems and the fourth on shapes.

From the selected 18 learners we used their work in showing how learners interpreted the graphical text and how they followed the instructions given by their teachers. In using both class work activities and Annual National Assessments tests we attempted provide a scenario of how learners engaged with problem-solving tasks.

We compared the performance of learners and checked if there is progression of ideas or interrelation of thought, when dealing with the everyday practice on concepts involving problem solving and whether the teacher met the National standard of questioning learners on problem solving. Learners often fail to perform well on a mathematical procedure if questions are asked indifferently from how they're used to, that is on 'routine problems and none routine problems' Mayer in Hartman (2001:87).

### **Descriptive analysis of teachers' responses to the interview**

In getting the results of how teachers taught problem solving, through the strategies enforced by GPLMS we provided the overview based on the results of the interview with them and the analysis of how they asked prompting questions during class exercises given to learners.

The purpose of establishing the descriptive results in this study is to show the performance of learners on problem solving by revealing how they have mastered the instructional practices of teachers when dealing with problem solving from the class room activities, (SBA) and on (ANA) 2014. In capturing an overview of how teachers provided information involving problem solving to their learners and how they gave instructions in classroom situation, the selected teachers were asked how they ask questions on problem solving. The teachers were requested to demonstrate how they showed learners to reach a solution to a particular question.

The overview indicates that all of the three teachers in general, were able to hold the attention of their learners moderately, however the learners were not exposed to different ways of tackling a problem, in responding to questions.

Presmeg in Moodley, Njisane and Presmeg (1992:38) suggest that teachers should be aware that learners differ in their need for visual aids or visual imaginary in learning mathematics. When teachers demonstrated to learners how to solve money problems for example, learners were not exposed to many opportunities in attempting to solve the problem.

The learners' interview were based on the four classroom exercises which encompassed solving money problems, fractions, word problems and shapes. We wanted learners to explain and demonstrate how they arrived at their answers. The results showed that six of these learners lacked basic skills on solving money problems, which is anchored on their failure to identify "more and less amount of money" this implies that they did not master the concept of size and comparison such as (more or less).

De Jong and Luneta (2011:9) suggest the importance of strengthening mathematical language and terminology in the early stage of children's learning. The significance of improvement programs on mathematics in education is to enable teachers maintain the primary goal of teaching mathematics which is to develop the ability to solve a wide variety of complex mathematical problems CAPS (2012). This study investigated how teachers of South Primary disseminated knowledge to their pupils on problem solving and how learners reacted towards teachers' instructions. The finding were that teachers could not comprehensively ask problems that enabled learners to acquire the skills of problem-solving and the learners grappled with problem-solving tasks.

Mathematical knowledge acquisition is the transformation of knowledge from the different forms in which it exists, into forms the learner can understand and use (Luneta 2013). In determining how knowledge was disseminated from teachers to their learners our findings seemed to concur with

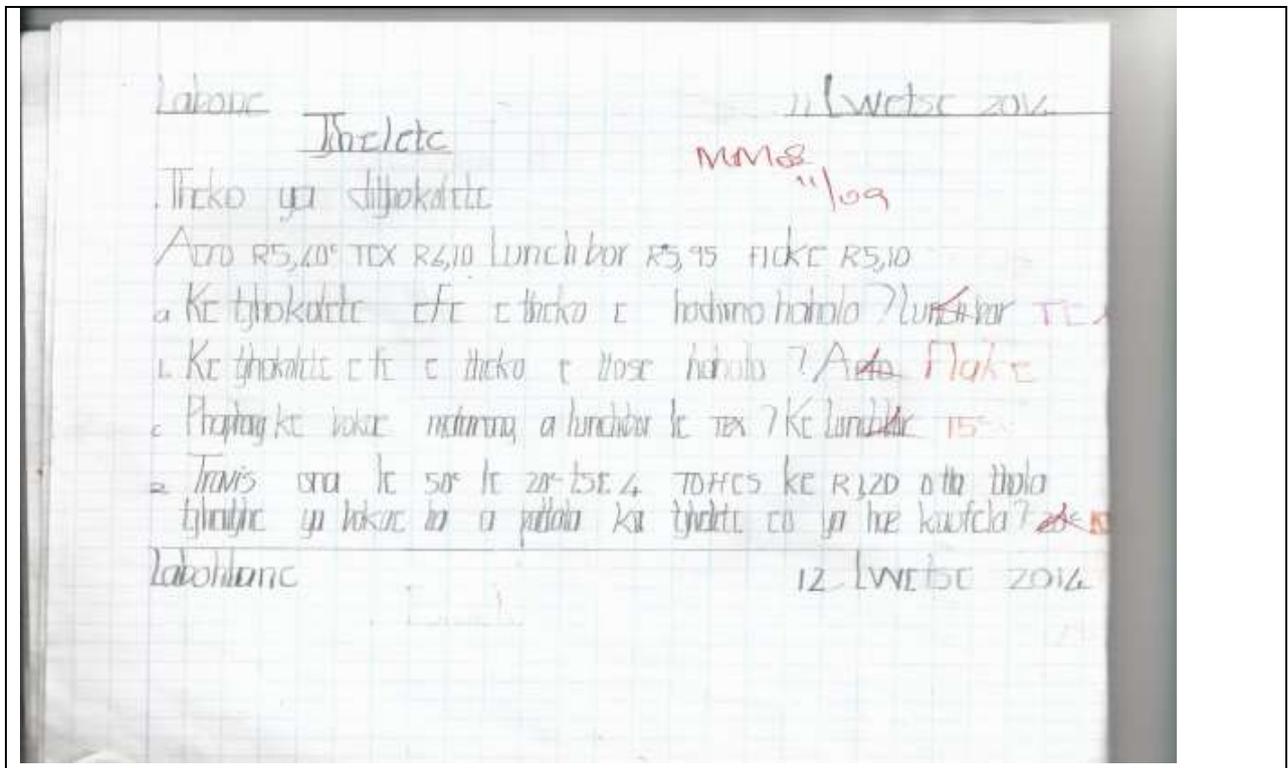
Luneta (2013) who posted that when teachers content and instructional knowledge is weak they tend to instruct procedurally and lack the usage of conceptual definitions resulting in learners acquiring weak concept definitions.

We concede that while GPLMS provides teachers with some glimpses of content Knowledge in reference to the reactions and performance of learners from the class works provided below and from the information gathered as we interviewed and observed them there were still problems instructionally.

**Illustration 1 (Example of how learners worked out question1 Class work.)**

(Questions were asked in Sesotho language, we had to translate the questions to English in order to allow readers to have an understanding and or make logic of the question.)

**Question 1 is depicted as follows: The prices of the chocolates that Pule has to buy are as follows Aero R5, 40c Tex R6, 10c Lunch bar R5, 95c and Flake R5, and 10c. (a) Which chocolate has the highest price? (b) Which chocolate has the lowest price? (c) What is the difference between the prices of Lunch bar and Tex? (d) Pule has two 50 cents and four 20 cents he would like to buy the Toffee which costs R1, 20c. How much will his change be?**



(a) How did you reach this answer? Nthabiseng: “Teacher told us.” Let’s look at the prices again, count from 1-6 then show me the highest price or a price with a bigger number? Nthabiseng:” it is R6, 10c.” What chocolate costs that price? Nthabiseng:” Tex.”

(b) How did you get the 2<sup>nd</sup> answer? Nthabiseng: “Eh.... I don’t know.” Count again from 1-6 and tell me which price is lower. Nthabiseng:” R5, 10c is Flake chocolate.”

(c) Show me how you got this answer? Nthabiseng:” I don’t know the answer.” Write the price of Lunch bar & Tex then subtracts the lower price from the higher price. Nthabiseng:” I can’t.”

(d) Show me how you reached the last answer? Nthabiseng:” I got it wrong.” Add the amounts that you were given then subtract the amount of the Toffee. Nthabiseng: “Ok”

Nthabiseng did not get the answers correct, but when a follow up was done she now showed an understanding of what she is expected to do, however she could not work on questions pertaining subtraction." *The simplest way of improving problem solving performance is to teach basic skills*" Mayer in Hartman (2001:89). Learners need the enriched foundation in learning in order for them to master concepts.

The results show that some learners did not understand the use of the relevant operational signs in answering questions e.g. On question1 (d) they were supposed to add the amounts provided  $50c + 20c + 20c + 20c + 20c = R1, 30c$  and then subtract  $R 1, 20c$  which is the price of the Toffee.

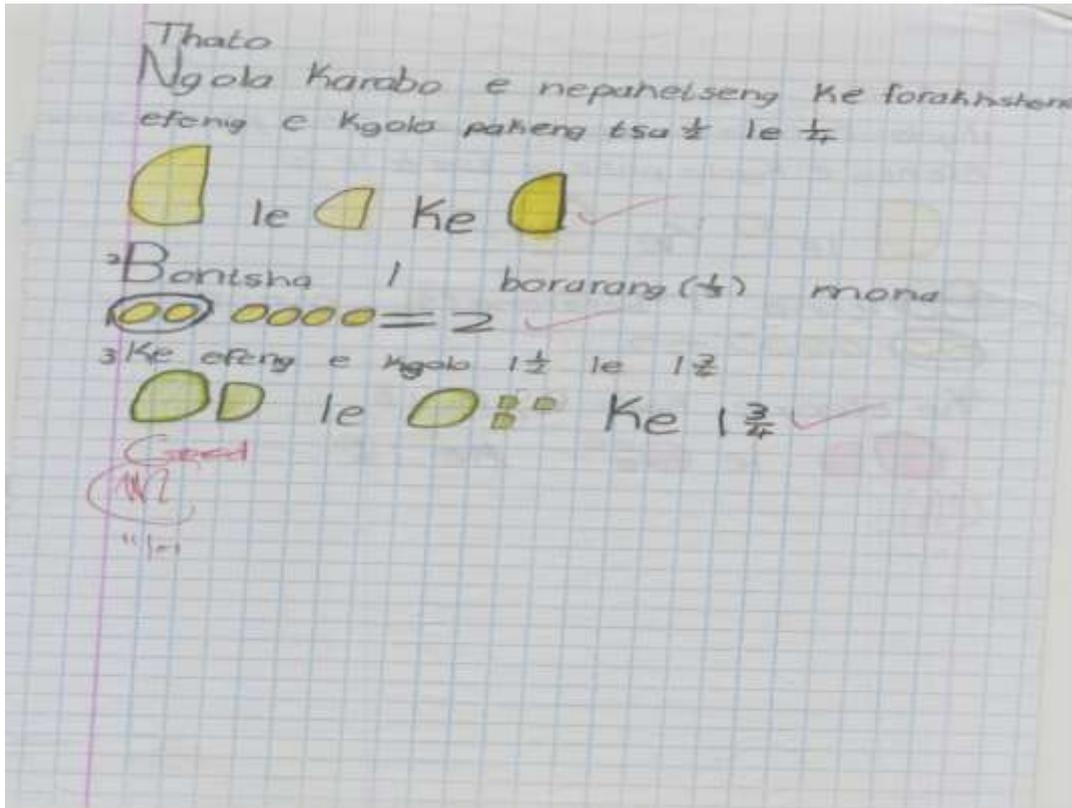
According to Mayer in Hartman (2001:94) to solve problems appropriately learners rely on the help and motivation of teachers, Mayer argues that the theories of problem solving instructions never emphasised the importance of motivation. Mayer, in (Hartman 2001:94) states that the will to learn depends on how the problem solver interprets the situation she/he is in. I maintain that teacher's instructional practices needs to provide learners with the basic content knowledge if the teacher uses adequate methods and approaches in giving instructions to learners. I therefore found Nthabiseng and other learners who were unable to work out answers to question 1, to be lacking understanding they still need reinforcement on the subject matter.

Luneta (2011,117) states that there should be a cyclic flow of information from the teachers to learners when engaging with problem solving activities so as to maintain critical thinking and argumentation by both teachers and learners. The GPLMS lessons requires teachers to teach according to the pre-specified program where teachers has to honour and follow the dates stipulated in order to complete the syllabus within the stated period. We found this to be disadvantaging learners who did not master the particular concept because teachers are under pressure in terms of syllabi completion.

An example of Curriculum Management Monitoring tool (CMM) is provided on Appendix 4. Allen and Johnston-Wider (2003:64) explain the importance of creating strong links between the teachers' views of mathematics, that is how teachers teach a particular concept, how they interact with their learners and how the learners views mathematics.

#### **Illustration 2 (Example of how learners worked out question2 Class work.)**

**Question2 is depicted as follows: Look at pictures showing different fractions & answer the following questions: - (a) which is the biggest fraction between  $\frac{1}{2}$  &  $\frac{1}{4}$ ? (b) Illustrate  $\frac{1}{3}$  of OOOOO? (c) which is the biggest fraction between  $1\frac{1}{2}$  &  $1\frac{3}{4}$  )?**



(Karabo got all the answers on fractions correct, he was able to demonstrate how he reached the solution)

The good practice demonstrated by Karabo and other learners shows that teachers were able to explain the instructional objective of solving problems related to fractions accordingly. This good practice is supported by Russell (2007) who suggests that the key to teaching young children fractions is to keep it concrete, such as using fraction strips, manipulatives and fraction circle. In addition Suhrit and Roma (2010) state that teaching of fractions should be encompassed by playing of games and usage of geometric drawings.

According to Curriculum Assessment Policy Statement (CAPS) Mathematics Grade R-3:

*“Shape and Space is the important part of young learners’ mathematical development, and should be spread out over the week, with some focused episodes under the guidance of the teacher, and many opportunities for construction, sand and water play by the learners”*

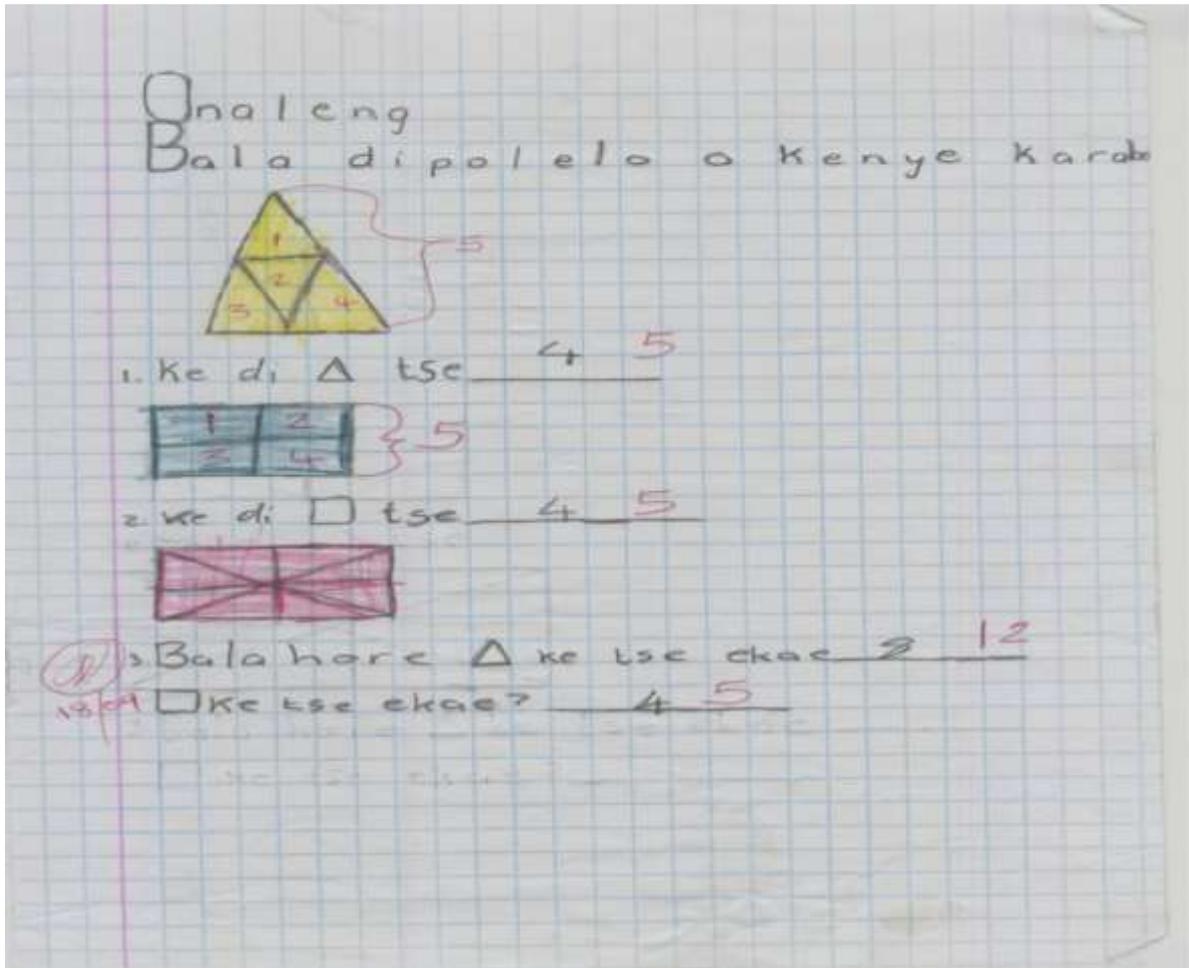
DBE (CAPS) Mathematics Grade R-3

De Villiers in Moodley, Njisane and Presmeg (1992:74, 75) suggests that problem solving should be regarded as the part of our daily classroom programme of mathematics teaching and that problems should be the integral part of every exercise. In referring to the work of Onaleng below and other learners who performed poorly on space and shape, I argue that GPLMS was able to provide teachers with the enriched content knowledge in line with CAPS.

We found two of the teachers to have displayed minimal content knowledge in regard with counting the triangles on question 3, as they repeatedly shown learners the wrong answer which they said was 12 triangles from the shape below. In reality there are 16 triangles. Shulman (1986:6) argues that many research scholars omitted the significance of the subject matter for the process of

teaching and learning, how the subject matter is transformed from the knowledge of the teacher into content of instructions.

**Illustration 3 (Example from the class work activity on shapes)**



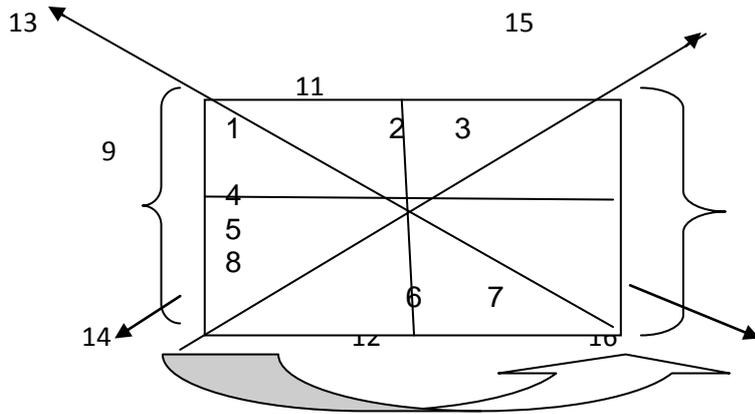
*(Onaleng was unable to respond to the entire questions asked)*

When we prompted her to show us how he counted the shapes from question 1, she said: **“Ahhhhh! O a bona hore ke kgutlonne tse nne.”** **“Ahhhhh! You can see that it is four squares.”** His response was evident to the fact that he lacked basic skills on understanding the sides, angles and number of shapes. In this research the teachers’ strategies were therefore found not to be promoting multiple perspectives on teaching mathematics in line with CAPS.

The teacher’s comment on question 3 above is that this shape has 12 triangles, which imply that she also perceive insufficient knowledge on teaching problems pertaining shapes.

*The diagram below is developed by the researcher which explains how the number of triangles should be counted from the drawing provided on question three above.*

Msimango(2014)



The illustration which indicates how the teacher and learners need to follow in determining the number of triangles from question three above.

**Illustration4 Examples of learners' work from ANA 2014 questions paper.**

*The ANA paper was written in Sesotho, I have translated the questions to English*

17.1 Tshepo eats two portions of the chocolate shown below. What fraction of the chocolate did he eat?

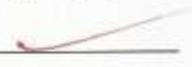
17.2 Lesego eats a quarter of the chocolate how many portions did he eat?

Nonhlanhla Grade 3A

17.1 Tshepo o ja dikarolwana tse 2 tsa t jhokolete e bontshitsweng ka tlase.



Tshepo o jele palophatlo/orakeshene e kae ya t jhokolete?

2  

17.2 Lesego o ja kotara ya t jhokolete e bontshitsweng ka tlase.



Lesego o jele dikarolwana tse kae?

2  

**(The correct answer to question 17.1 is  $\frac{1}{2}$  and not 2 as indicated by the teacher above.)**

Question 17 is based on simple and or proper fractions, Buthelezi, Dhamini, Lubombo and Ponte (2007) express the fundamental of basic number sense in the context of self-knowledge, majority of Grade 3 learners including Nonhlanhla, Thato and Lebo were unable to show the basic knowledge and skills on sharing. On contrary these learners performed well on the class activities regarding fractions this confirms what Mayer in Hartman (2001:97) suggest to be routine and non routine problems for learners, which implies that learners become acquainted with the types of questions asked by their teachers on daily basis and fail to respond to the similar questions if they're asked differently. Teachers should not focus on rules only when teaching fractions but on the total sequence of ideas with the emphasis on the initial conceptual work with fractions (Jooste: 1999).

It can therefore be concluded that teachers in primary schools still need to be trained on how to instruct in such ways that enable learners to acquire the skills of problem –solving and critical thinking. The procedural methods of teaching where teacher guide learners through algorithmic procedures only reinforces rote learning and very little conceptual understanding. We advocate for what Luneta (2012: 362) calls 'High quality professional development programs, the kind that produce change in teaching practice and student outcome'.

## References

- Allen, B. & Johnston-Wilder, S. (2003). *Mathematics Education: Exploring the culture learning*. RoutledgeFalmer. London.
- Bennett, A. B. and Nelson, JR. /L.T. (1998). *Mathematics for elementary teachers. 4<sup>th</sup> Edition*. McGraw-Hill Companies, Inc. United States.
- Bernard, H. R and Ryan, G. W. *Analyzing Qualitative Data Systemic Approach*. Sage Publications Inc. Creswell
- De Jong, D. & Luneta, K. (2010). *Teaching Numeracy, the teachers' choice*. Johannesburg, Heinemann Publishers (Pty) Ltd.
- Department of Basic Education (2011). Curriculum and Assessment Policy Statement. Mathematics, Grade R-3.
- Department of Education (2011-2013). *Annual National Assessments*. Pretoria: Government Printers.
- Dlamini, M., Lubombo, A., & Ponte, J. (2003b). *Classroom Mathematics Grade 1 (Teacher's Guide)*. Sandton: Heinemann.
- Empson, S. (1995). Using situations to help children learn fractions. *Teaching children Mathematics*, October, 110-114.
- Henning, E., Gravett, S. & Van Rensburg, W. (2005). *Finding your way in Academic Writing (2<sup>nd</sup> ed.)*. Pretoria: Van Schaik.
- Jooste, Z. (1999). *Grades 3 & 4 learners deal with fractions problem in context*. Paper presented at the 5<sup>th</sup> Annual Congress of the Association for Mathematics Education of South Africa.
- Lukhele, B.K, Murray, H. & Olivier, A. (1999). *Learners' understanding of the addition of fractions*. Proceedings of the Fifth Annual Congress of the Association for Mathematics Education of South Africa.
- Luneta, K. (2013). *Teaching Elementary Mathematics*. Lambert Academics Publishing.
- Luneta, K. (2012). Designing continuous professional development programmes for teachers: A literature review. *Africa Education Review*. 9(2) 360-379.
- Luneta, K. (2011). *Initial Teacher Education in Southern Africa: Mentorship and Teaching Practicum Supervision*. Lambert Academics Publications.
- Leikin, R. And Zazkis, R. (2010). *Learning through Teaching Mathematics: Mathematics Teacher Education Volme 5*. Springer Science Business Media.



Maree, K. (2010). *First Steps in Research*. Pretoria: Van Schaik Publishers.

Maxwell, J.A (2013) *Qualitative Research Design 3<sup>rd</sup> Edition*. Sage Publications Inc.

Mayer, R.E. in Hartman, H.J.(ed.),(2001). *Metacognition in Learning and Instruction: Theory, Research and Practice*. Kluwer Academic Publishers. Printed in the Netherlands.

Merriam, S.B. (2002). *(b) Qualitative Research in Practice: Examples for discussion and analysis 1<sup>st</sup> ed.* Jossey-Bass in San Francisco.

Moloi, M. & Strauss, J. (2005). *The SACMEQ II Project in South Africa: A Study of the conditions of schooling and the quality of education*. Harare: SACMEQ.

Moodley, M. Njisane, R.A. and Presmeg, N.C. (1992). *Mathematics Education for In-Service and Pre-Service Teachers*.

Mouton, J. (1996). *Understanding Social Research*. Van Schaik Publishers.

Mouton, J. (2001). *How to succeed in your Master's & Doctoral Studies, A South African Guide and Resource Book*. Van Schaik Pretoria.

Polya, G. (1945). *How to solve it: A new aspects of Mathematics Method 2<sup>nd</sup> Ed.* Princeton University Press, New Jersey.

Russel, D. (2007). *Mathematics Guide: Teaching Fractions*.

Shavelson, R.J., Mcdonell, L.M., & Oakes, J. (1989). *Indicators for Monitoring Mathematics & Science Education a Sourcebook*. Santa Monica (CA, USA): The RAND Corporation.

Saldana, J. (2009). *The coding Manual for Qualitative Researchers*. SAGE Publications Ltd London.

Shulman, L.S. (1986). *Those Who Understand: Knowledge Growth in Teaching. Educational Researcher*, Vol. 15, No. 2. Stanford University.

Suhrit, K.D. & Roma, D. (2010). Teaching Primary Arithmetics Fractions Using Geometry: *Journal of Mathematics Education*, December 2010, Volume 3, 170-182.

Taylor, N.C, Muller, J.P., & Vinjevoid, P. (2003). *Getting Schools Working: research and systemic school reform in South Africa*. Cape Town: Pearson Education Publishers.

Trends in International mathematics and Science (TIMSS) (2011). *Towards equity and excellence: South African Perspective*. Pretoria: Human Science Research Council

## APPENDICES

### Appendix 1. Transcript showing coding of data from an interview

| Raw Data                                                                                                                                                                                                                                                                                                                                                                                                   | Categories                                                | Themes                                                                                                                                                                                                                                              | Patterns in Themes                                                                                                                | Codes               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <p><b>Interviewer:</b> Have you attended GPLMS workshops, how did the workshops help you in regard with instructional skills based on problem solving?</p> <p><b>Teacher A:</b> Yes, but not always. Well..... the <u>workshops helped</u> me a lot because I did not understand how to teach fractions but now I am able to teach my learners with ease.</p> <p><b>Teacher B:</b> I have attended the</p> | <p>teach</p> <p>helped</p> <p>understand</p> <p>GPLMS</p> | <p>Themes are "concepts" grouped together in a higher order of classification to form categories Straus &amp; Corbin (1990:61).</p> <p>Themes come from data and from the researcher's prior theoretical understanding of the phenomenon one is</p> | <p>Instructional quality</p> <p>-to teach adequately</p> <p>-improved pedagogical content knowledge</p> <p>Curriculum quality</p> | <p>IQ</p> <p>CQ</p> |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <p>workshops on GPLMS, Ehhhh.... (<i>hesitate</i>) I can say they are really helpful in general. Ehhh..... I can't say particularly on problem solving because the mentors never assisted me on that, but I found help from the lesson plans as they have <u>good steps</u>.</p> <p><b>Teacher c:</b> Mmhh..... (<i>hesitating</i>) Woo..... Of course I have attended workshops, but it is hard for me to explain how the workshops has helped me on problem solving, Ehh..... let me say GPLMS workshops helped me to <u>follow steps</u> when explaining to learners how to solve a mathematical problem.</p> | <p><i>steps</i></p> <p><i>help</i></p> <p><i>helpful</i></p> <p><i>lesson plans</i></p> <p><i>steps</i></p> <p><i>explaining</i></p> <p><i>learners</i></p> | <p>studying (Bernard &amp; Ryan 2010).</p> <p><i>Instructional quality</i></p> <p><i>Curriculum quality</i></p> <p><i>Attitudes &amp; actions</i></p> <p><i>Teaching quality</i></p> <p><i>Mathematical achievement</i></p> | <p>-enriched core curricular</p> <p>-adequate skills on problem solving</p> <p><i>Attitudes &amp; actions</i></p> <p>-good relations on subject matter</p> <p>-lack of confidence on Service Provider(GPLMS)</p> <p><i>Teaching quality</i></p> <p><i>-improved mathematical skills &amp; strategies</i></p> | <p>AA</p> <p>TQ</p> |
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Appendix 2: An example based on the video clip transcript

| Time Episode in minutes | Teachers' Instructional Approach & Strategies with References                                                                                                                                                                                          | Scoring average score in each episode time (1-5)1 is poor 5 is very good | Explanation/motivation                                                                                                                                 |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0-15                    | <p>A. How the teachers introduce concepts involving problem solving to learners. According to Luneta (2013:9) teachers' instructional approach is regarded as effective if it enables learners to understand and be able to apply what they learn.</p> | 4                                                                        | <p>Teachers were able to use relevant resources &amp; information in introducing concepts involving problem solving. Learners were able to follow.</p> |
| 15-30                   |                                                                                                                                                                                                                                                        | 5                                                                        |                                                                                                                                                        |
| 30-45                   |                                                                                                                                                                                                                                                        | 4                                                                        |                                                                                                                                                        |
|                         |                                                                                                                                                                                                                                                        | (13/15)                                                                  |                                                                                                                                                        |
| 15-30                   | <p>B. The teachers' content knowledge has to be reflected by examples they demonstrate to learners on particular concepts. Shulman (1986), Leikin and</p>                                                                                              | 3                                                                        | <p>Teacher A &amp; C were unable to provide learners with accurate knowledge</p>                                                                       |
| 30-45                   |                                                                                                                                                                                                                                                        | 4                                                                        |                                                                                                                                                        |
| 45-55                   |                                                                                                                                                                                                                                                        | 2                                                                        |                                                                                                                                                        |

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                            |                                                                                                                                                                                                                                                                                                                                                                          |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | Zazkis (2010) emphasise the importance of teachers' knowledge on maintaining quality standards when teaching learners to learn effectively.                                                                                                                                                                                                                                                                                              | (9/15)                     | when counting the number of 's. ( <i>There are 12 triangles</i> ). That was the answer which the teachers gave to their learners. Instead of counting 16 's. Most of learners were unable to complete the money activity on time & accurately as they had to count using many circles, this confused learners when they had to count huge numbers & work on subtraction. |
| 0-10 | C. How teachers give instructions & ask questions. This factor is idealized by (Leikin 2005) in Leikin and Zazkin (2010:9) when suggesting a model for analysis of teachers' interactions in a system of six themes – " <i>Purpose for interaction of the teacher &amp; learner, Initiation by either the teacher or learners, Motives, Reflection on experiences, Actions that support the interaction, Focus of the interaction</i> ". | 4<br>5<br>3<br><br>(12/15) | Some teachers were showing little effort in terms of making a follow up on learners who did not understand the instructions or questions. ( <i>How much is left when you subtract R20,00 from R 39,00</i> ) some learners were unable to follow instructions.                                                                                                            |