

EXPLORING THE MATHEMATICAL PROFICIENCY OF GRADE 6 TEACHERS: A CASE OF GAUTENG TSHWANE EAST

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As part of the community engagement initiative, the Department of Mathematics Education (DME), at the University of South Africa (UNISA), conducted a pilot study to explore the mathematics proficiency of teachers in Gauteng Tshwane East district. Six Grade 6 mathematics teachers from 11 schools participated in the study. We conceptualize proficiency as a multi-faceted notion having dimensions of teacher knowledge, instructional practices, assessment practices and contextual factors. We adopted a mixed-methods approach consisting of exploratory and survey designs with both qualitative and quantitative approaches. For triangulation, three instruments were used, namely, teacher questionnaire, teacher interviews as well as classroom observation schedule. The results of the study suggested that study participants are proficient in terms of demonstrating the following aspects of classroom instruction: mathematics knowledge, appropriate assessment techniques; ability to handle educational and socio-economic challenges. Further analysis of data revealed that teachers' proficiency is however downplayed by a persistent emergence of unintended issues relating to educational and socio-economic challenges. In turn, because the educational agenda is altered teachers fall short in realizing the full potential of their teaching proficiency. We therefore recommend that the unintended issues should be addressed in order to lay suitable ground for effective instruction. We further acknowledge that the insights gained from this pilot should assist the DME to design training programs to equip mathematics teachers to mitigate the influence of the unintended classroom agenda.

Keywords: Mathematical proficiency; teacher knowledge; instructional practices; assessment, and mathematics teachers

INTRODUCTION

The poor performance in mathematics has continued to become a great source of worry in many countries around the world. In an attempt to address this problem South Africa has participated in several evaluative and comparative studies that were conducted at national, continental and international levels, in order to identify the actual status of the problem. Results from these participations consistently point to a serious problem to the quality of mathematics instruction in South Africa.

In 2000 and 2007, Grade 6 learners in South Africa participated in the Southern and East African Consortium for Monitoring Educational Quality (SACMEQ) studies, and were tested in mathematics (numeracy) and reading (literacy). In the 2000 study (SACMEQ II) around 80% of South African Grade 6 learners that participated reached the lower half of eight levels of competence in mathematics on the SACMEQ continuum (Moloi & Strauss, 2005). The results of both 2000 and 2007 participation by South African learners are shown in Table 1. The results in Table 1.1 show that the mathematics performance of Grade 6 learners in South Africa is not very good. In 2000, three provinces scored above the SACMEQ II mean average of 500. However, the country's average mean was 486. Again, in 2007 South Africa failed to reach the SACMEQ III average of 510. The SACMEQ (2013) has observed that although South Africa has made significant strides taken to transform the nation from pre-1994 apartheid system, the main challenge that remains almost intact is improving the levels and quality of educational outcomes as measured by the reading and mathematics, Rasch score obtained by the Grade 6 learners in SACMEQ tests.

Table 1: South Africa's performance in the reading and mathematics in the SACMEQ II and SACMEQ III

	Pupil reading score		Pupil mathematics score	
	2000	2007	2000	2007
Eastern Cape	444	448 ▶	449	469 ▲
Free State	446	491 ▲	448	492 ▲
Gauteng	576	573 ▶	552	545 ▶
KwaZulu-Natal	517	486 ▼	510	485 ▼
Mpumalanga	428	474 ▲	433	476 ▲
Northern Cape	470	506 ▲	461	499 ▲
Limpopo	437	425 ▼	446	447 ▶
North West	428	506 ▲	420	503 ▲
Western Cape	629	583 ▼	591	566 ▼
SOUTH AFRICA	492	495 ▶	486	495 ▶
SACMEQ	500	512 ▲	500	510 ▶

Values in **Green** = 10 points or more above SACMEQ II mean of 500

Values in **Black** = less than 10 points above or below SACMEQ II mean of 500

Values in **Red** = 10 points or more below SACMEQ II mean of 500

Notes about trend:

▲ Increased by 10 points or more

▶ Minimal change (less than ±10)

▼ Decreased by 10 points or more

Source: SACMEQ (2013)

Some researchers believe that the remnants of apartheid play a significant role in the teaching and learning of mathematics in South African schools. The rationale for this line of thinking is based on the type of teachers who were trained under the apartheid system.

These teachers have been identified at primary level in mathematics (Howie, 2001; Moloi & Strauss, 2005) and at secondary level in mathematics (Howie, 2001) as unqualified and under qualified. This has continually resulted in an increasing poor Grade 12 output and the majority of learners who do not meet the minimum requirements for university entrance (Modisaotsile, 2012).

Although factors such as overcrowded classrooms, high dropout rate, low literacy and numeracy, snail's pace of teachers progress through curriculum, lack of resources, and ineffective leadership management, have been identified, poor teacher training, unskilled teachers, lack of commitment to teach by teachers and a shortage of resources in education seem to be the most determinant of learners' poor performance in mathematics. We believe the latter factors are closely related to the notion of proficiency that a teacher is supposed to reflect at classroom level. This paper reports on a study that explored the teaching proficiency of Grade 6 mathematics teachers, and primarily taking into cognisance the existence and emergence of other factors that have a direct bearing on the teaching and learning process.

AIM OF THE STUDY

This study was aimed at identifying teachers' proficiency in the teaching and learning of mathematics in primary schools. To achieve this aim, researchers set out the following objectives for the study:

- To evaluate the teachers' mathematical knowledge for teaching;
- To determine the teacher's ability to interact effectively with learners in order to promote meaningful learning; and,
- To ascertain teachers' ability to deal with learners' educational and socio-economic factors that may affect performance in mathematics.

CONCEPTUAL FRAMEWORK

Studies that have explored the notion of proficiency have largely focussed on learners (Kilpatrick, Swafford, & Findell, 2001). The study that is reported in this paper offers a unique dimension in that its focus is on the teaching proficiency of mathematics teachers. With regard to teachers, we conceptualize proficiency as a multi-faceted, multi-layered notion hence the dimensions of proficient teaching that we reflect in this paper are: (i) teacher's content knowledge, (ii) teacher's instructional practices within a well-defined classroom environment, (iii) teacher's use of assessment techniques to complement and develop the lesson, and (iv) teacher's response to contextual factors that impact on the development of learners.

Thus in short, we define a proficient teacher is defined as one who has: (i) mathematical knowledge for teaching, (ii) background awareness of the learners (sensitive to the social variables, environmental factors), (iii) abilities to interact effectively with learners, (iv) reflects meaningful habits of reflection towards the teaching practice, and (v) demonstrate understanding of teaching that is situated in a problem solving environment.

Among all the dimensions of proficient teaching that we present in this paper, we regard teacher's subject matter knowledge (SMK) as being the most significant and fundamental variable. This thinking is in line with the view that the quality of instruction that teachers provide for the learners is largely influenced by the quality of knowledge the teachers possess since teacher subject matter knowledge of mathematics, for instance, is fundamental to teacher ability to provide effective mathematics teaching (Ball, Hill, & Bass, 2005; Kreber, 2002). Therefore, the ineffectiveness of the mathematics teachers or the teaching proficiency of these teachers could be a major determinant for the learners' performance in mathematics.

OUR STUDY

Research design

This study adopted a mixed-methods approach consisting of exploratory and survey research designs. The survey research design informed the researchers what the teachers' level of mathematical knowledge for teaching is, and what strategies teachers use to address the confounding issues of educational and socio-economic origin. In addition, the exploratory research helped to determine the current status of the teachers' proficiency in mathematics. This paper reports specifically on the data collected for pilot purposes in order to initially familiarise researchers with the teaching proficiency of mathematics. The results of this exploration will later inform an envisaged intervention strategy for the improvement of teachers' proficiency in mathematics.

Population and sample

The population for the study comprised of Grade 6 mathematics teachers in the intermediate phase (Grade 4 to Grade 6) in the Gauteng¹ Tshwane district. From this population 11 primary schools participated in the study. Grade 6 is purposefully chosen because it is part of the action plan 2014 towards the realisation of schooling 2025 (Department of Basic Education [DBE] 2012: 8), which places Grade 6 as one of the focal grade levels. From the 11 primary schools six teachers participated in the study.

A convenience sampling technique was utilized to select schools that will provide easy access and maximization of data collection for the study.

¹ Gauteng is one of the nine provinces of South Africa.

Permission to conduct this research was sought and acquired from the Gauteng Department of Education as well as principal and Grade 6 teachers of the respective schools.

Instrumentation

The three instruments that were used in this study were administered on six Grade 6 mathematics teachers, and these were lesson observation schedule, interviews and questionnaires. The questionnaires explored teachers' demographic details (section B) and issues relating to classroom practice (section B). Some of the issues addressed in Section B were teaching practices, teaching material and curriculum implementation. The interview schedule explored the following issues: (i) mathematical knowledge for teaching, (ii) instructional practices, (iii) assessment practices, and, (iv) educational and socio-economic factors. Some of the issues that were addressed by the lesson observation included: the availability of the lesson plan, teacher-learner interaction, demonstration of teachers' knowledge, use of assessment techniques as well as the availability of resources. Given that this study took the format of a pilot exercise, the assessment of measurement properties of each instrument would then be addressed during the course of data analysis.

Data analysis

Both qualitative and quantitative methods of data analysis were used.

Questionnaire

Data from the teachers' questionnaire show that of the six teachers only one has a degree qualification (BEd) in mathematics, while four were in possession of a three year senior primary teachers' diploma, and one had an Advanced Certificate in Education (ACE). Furthermore, it was noted that the level and depth of content knowledge in most of the qualifications that teachers possessed did not exceed that of the learners. Of the 11 teachers only two were studying further and one of them was studying towards school management. We observe that studies that are geared towards a management direction do not necessarily empower teachers to enhance their teaching proficiency as management studies are primarily appropriated towards school management and leadership issues. The qualifications of teachers (n=6) are represented in Table 1.

Table 2: The qualifications of teachers who participated in the study (n=6)

Types of teaching qualification	Highest qualification in Mathematics	Further studies
ACE, n=1	Less than Grade 12, n=1	No, n =4
SPTD ² , n=4	Grade 12, n=2	
BEd ³ Hons, n=1	More than Grade 12, n=3	Yes, n=2

In addition to the teachers' qualifications in Table 1, we also found that four teachers had more than 10 years experience of teaching Grade 6 mathematics, while one had less than 6 years and the other had just started teaching. The latter had previously taught high school mathematics but joined the intermediate phase for promotional purposes. Two teachers indicated that their classes were overcrowded while others reported that their classes were manageable at 43 and 45. With regard to the level of readiness to implement the Curriculum and Assessment Policy Statement (CAPS), only one teacher indicated that she was 'completely ready' while two teachers indicated to be 'almost ready' and three were 'slight ready'.

Teacher interviews

The interviews were meant to address the following themes:

Mathematical knowledge for teaching

Five teachers indicated that the CAPS training they received for mathematics teaching in Grade 6 was inadequate since it was run in a period that was less than a week. For instance, one teacher said:

'Yes, when I did PTC and diploma (previous Vista University) in mathematics, the training was enough. But knowledge changes every day, and one needs to keep abreast. Learning is lifelong.'

In an attempt to improve her teaching proficiency this teacher has made special effort to join the Association of Mathematics Educators of South Africa (AMESA) for the enrichment of mathematics teaching. She further indicated that she attends all workshops, especially those that are content related. Generally, teachers indicated that they receive training and attend workshops that are organised by the Department of Basic Education (DBE), the Non-Governmental Organisations (NGO's), Higher Education Institutions and those arranged by mathematics education associations.

² SPTD is an acronym for Senior Primary Teachers' Diploma.

³ BEd stands for Bachelor of Education.

As a follow up, teachers were further asked to reflect on the extent to which these trainings and workshops impacted on their teaching of mathematics. All teachers (n=6) indicated that the workshops/ training were helpful as captured in the following extracts:

“These workshops are helpful and open doors for us to see where we lack knowledge and how to close the gap”.

‘It clarified a lot of topics that I did not understand in mathematics’

Instructional practices

Teachers reported teaching practices that ranged from the old traditional (conventional) methods, such as telling method/ information session, and textbook method, to the reform approaches, which represented group work, examples method, questioning skills, investigations, and problem solving. Teachers who favoured the group approach mentioned that this teaching method is facilitated by grouping learners heterogeneously. The other teacher emphasized that learners’ opinions were valued in her lesson. Other teachers indicated that using real-life examples them to facilitate the understanding of the mathematical concepts by moving from the known to the unknown (from concrete to abstract). It also appeared that teachers use different yardsticks to measure the effectiveness of the method of teaching used in mathematics. Some teachers measured the effectiveness of their instruction in terms of learner performance, while others used learner participation (classroom interactions) as a measure. For example, one teacher reported that group work led to the learners sharing ideas and demonstrating improved participation and communication. Another teacher said:

‘Yes, there is 100% pass rate.’ And she continued to say,

‘If the pass rate drops, then the method is not effective.’

Learners learn from others in the group, getting explanations about the project from others.

With regard to learners’ learning difficulties teachers said they identified them through assessment activities such as class test, non-participation in activities, misinterpretation of questions, language challenges as a barrier and sometimes when the learners find it difficult to do mental mathematics.

They further reported that learning difficulties would then be rectified by using mother tongue to explain the concept (code-switching), re-assessment, and initiating remedial programs and extra classes either in the afternoon or in the morning, but teachers insisted that the afternoon classes were mostly impossible carry out since the learners use common transport and are to leave immediately after school.

Another teacher reported that her struggling learners are referred to the School Based Support Team (SBST), which deals specifically with learners who experience challenges during learning. The SBST units are subject-specific.

Assessment methods used to facilitate learning

Tests, assignments, projects, investigations, examinations, homework, classwork and research were some of the assessment methods suggested to be useful during mathematics lesson. These assessment techniques helped the teachers to improve their practice, to improve and identify learners who have passion for mathematics. The classwork (CW) and the homework (HW) received a popular approval from the teachers (n=6). Teachers insisted the two forms of assessment, CW and HW, were informal in nature but are useful to provide a formidable preceding foundation for the formal assessments such as tests, assessments, assignments and projects. In particular, classwork was chosen as the most beneficial method since it was mentioned to be a tool to measure the effectiveness of all other assessment methods. CW can be used to identify learners' problems early before the test. Homework was indicated by one teacher to be the one done after more understanding and helps the learners to revisit the work done. On the average teachers rated the significance of assessment as an indicator of the efficiency of the teaching method. Assessment helps to design a responsive instruction and could help the teacher to do a self-reflection to improve the lesson instruction.

Educational and socio-economic influences on the learning of mathematics

Socio-economic factors that teachers highlighted included learners' challenges of poverty, learners' places of dwelling, which in this context was shacks or informal settlement that is largely without electricity and other basic services, the fact that learners do not do homework, poor concentration in class, unavailability of school uniform that lead to the affected learners being given by the school the uniform from previous learners (uniform exchange), child-headed families, learners staying with grandparents who are largely illiterate and unable to help children with homework. The educational factors included that emanated during data collection included learners with learning barriers and those who were described by teachers as having 'very low IQ'.

The teachers revealed that learners who are affected by both socio-economic and educational barriers are identified through the following methods and behaviours: non-participation in class, withdrawal from classroom activities, being an orphan, visitations to their homes, learners who are restless in class, learners who are always tired, learners who always visit the sickroom, and at times asking learners directly and personalized learners.

Uniform exchange, involvement of social workers and social care initiatives, home visits and the feeding scheme (a program where needy learners are provided with food at school) were indicated as preferred methods of addressing the educational and socio-economic factors that affect the learning process. Sometimes these challenges are addressed by the School Management Team (SMT), and parents are also invited to the school. Teachers describe the impact of these factors as having a negative influence on: (i) the pace at which the teacher are supposed to be teaching, (ii) the focus and concentration of learners in class, (iii) the quality of work produced by the affected learner,, (iv) the extent of interaction that the learner enjoys with fellow learners, (v) the self-esteem of the learner. The other point that was highlighted by teachers was that learners who are adversely affected by socio-economic and educational challenges end up losing interest in the educational agenda. These learners eventually become motivated to go to school by the fact that they get food and that the transport is provided from them to go to school.

Classroom observation schedule

The classroom observations looked at the availability of the lesson plan, approaches used to introduce the lesson, general class management, teacher interaction with learners, teachers' knowledge, the use of chalkboard, as well as assessment strategies that characterize instruction. All the teachers that participated in this study were part of GPLMS⁴ program that which was launched for primary schools by the Gauteng Department of Education. This arrangement made it possible for all teachers (n=6) to have lesson plans. However, as researchers we wanted to look at how the teachers articulated the lesson plan, hence we conducted lesson observations to inform our judgement in this regard.

⁴ GPLMS refers to Gauteng Primary Language and Mathematics Strategy, which is a special intervention program that was launched by the Gauteng department of Education to improve learners' performance.

Upon our interaction with teachers, they registered a concern that a template given to them as a work schedule deprived them the freedom that would allow them to manifest their teaching proficiencies. They mentioned that the templates prescribe the programme of activities for teachers, which at times fail to address immediate educational needs for learners. For example, the mental mathematics activity for learners is allocated 6 minutes and this arrangement seems not to allow learners to digest accordingly the conceptual material embedded in this learning activity. Therefore teachers are seemingly not happy with the DBE arrangement and prescriptions as they limit their innovative abilities. They felt their professional competences are undermined.

This disadvantages the learners since the teacher has to move to the next concept even if the teacher realizes that learners have not understood the concept. Therefore at times the time allocated to teach certain concept is insufficient. For example, the Grade 6 schedule for mathematics prescribes that fractions should be taught within two hours. In this regard one teacher noted:

'...but because you want to comply, you need to move to the next topic even if you have not exhausted the previous one. You just have to touch on a certain topic so as to have evidence in the learners' book to show the facilitator.'

The preceding comment by the teacher highlights some of the variable that impact negatively to the nourishment of the proficiency of teachers in Grade 6. Teachers opt to comply, as suggested by the comment, and subsequently hold back their inputs to the teaching and learning process. Using observations from the tool of lesson observation, researchers felt that teachers demonstrated proficiency in the following areas of exploration:

(i) Interaction with their learners

During a lesson presentation most teachers demonstrated familiarity with the use of reformed methods of teaching, such as allowing the lesson to be learner-centred. Other teachers were observed to be moving around in class in order to provide individual assistance to learners. Also, learners were readily posing questions to the teachers from time to time.

(ii) Mathematical knowledge

Our observation as researchers reflected that teachers were adequately knowledgeable in their subject matter. This was demonstrated when teachers satisfactorily provided useful explanation of concepts they were teaching. The use of real-life examples characterised the facilitation and the development of the lesson.

(iii) Usage of chalkboard

Not all teachers made use of the chalkboard during observation. However the few teachers that used this teaching equipment were observed to be efficient. When writing on the chalkboard the work was partitioned into sections and the handwriting was legible. In some instances learners were called to come in front to represent their responses on the chalkboard.

(iv) Demonstration of assessment techniques

During lesson observations, the following assessment strategies were observed: Peer assessment, usage of mental mathematics activity, oral questioning, classwork and homework.

DISCUSSIONS AND CONCLUSIONS

Given the reported activities of this exploratory study, the research was launched in participating schools with an aim to explore the levels of proficiency of mathematics teachers in Grade 6. The results of this study reveal that the nourishment and effective growth of teachers' proficiency is downplayed by variables such as those relating to socioeconomic factors and language demands. The lesson observations, which were conducted on teachers seem to suggest that teachers have the required level of mathematics proficiency that is needed to teach Grade 6 learners certain concepts of mathematics. However, challenges that persistently play themselves out during the course of instruction create an atmosphere that makes it possible for teachers to adequately exhibit pedagogical qualities of proficiency. For instance, most learners who are taught by these teachers experience pressing challenges that eventually detract their focus from the intended educational agenda, and this aspect impacts negatively to the manifestation of the qualities of proficiency of the teacher.

In essence, the results of this study help us to realize that the conditions in the selected schools are not educationally conducive to allow teachers to manifest aspects of proficiency in their subject. The emergence of issues of poverty continues to confront teachers in a manner that tragically defeats the agenda of teaching and learning. Instead of grounding themselves with issues of teaching and learning, which should nourish their instructional proficiency, teachers have to deal with issues of hunger, abuse and low esteem that are entrenched in the daily lives of their learners. This circle of realistic events contributes negatively to the teaching and learning agenda. As mentioned in the analysis, in almost all schools, teachers were using GDE developed lesson plans (GPLMS), which they are expected to follow to the latter. Researchers observed a disjuncture with regards to the implementation of the lessons plans versus their proficiency. The fact that the already-prepared lessons do not create space for teachers to

navigate freely through the syllabus; it seems the opportunities for teachers to strengthen their teaching proficiencies are subsequently diluted.

We therefore recommend that the confounding influence of unintended factors that continue to play themselves in mathematics classrooms should be mitigated effectively in order to facilitate teaching and learning in our schools.

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