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Towards establishing a baseline for the professional development of secondary mathematics teachers in South Africa.

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Abstract

This paper presents part of baseline information on the activities done by teachers in their classrooms. This is done with the purpose of establishing professional intervention, which will address the professional needs of secondary mathematics teachers in the South African context. The data on the teachers' classroom practice with regard to teaching styles, content knowledge, overt professional attitudes and classroom management was collected using classroom observations. This research was carried out with the teachers in their own classrooms in keeping with the situative approach for research in teacher education (Putnam & Borko, p. 4, 2000). The findings will be used to guide professional development intervention for secondary mathematics teachers.

Introduction

The number of pupils in South Africa who pass grade 12 mathematics and physical science at Higher Grade is very small and getting smaller. For example, in the year 2000, only 19,300 passed HG mathematics (and 23,300 passed higher grade physical science) (Department of Education, 2001). In order to try to improve these results, it is reasonable to look to the teachers. A large number of mathematics and science teachers are either unqualified or under qualified in these subjects (Arnott and Kubeka, 1997). In addition, a study of mathematics and science teachers' professional attitudes (Grayson et al, 2001) indicated that many teachers hold unprofessional attitudes that greatly contribute to the poor performance of their learners. Furthermore, many classes are dominated by "teacher talk and low-level questions" (Taylor and Vinjevold, 1999), an approach which is unlikely to develop the thinking skills needed to succeed in mathematics and science.

In South Africa, apartheid deliberately created vast inequalities for peoples of different racial groups. As a result many teachers in black schools were left de-motivated, had little or no resources in schools and many learners lacking inspiration. It was necessary to do research with teachers in their schools to look into what could be done to improve the situation.

Background

Mathematics education researchers seek to find ways in which professional development interventions could be directed to teachers in order to impact on learners' performance. There is however, a 'research-practice gap' as seen in the quotes from John Malone's key note address, entitled, Bridging the gap: A challenge for the dual community (23rd MERGA conference, 2000).

"Mathematics education research should be useful to me, but it really isn't. It looks at what teachers should do to make mathematics better, but ignores what's really going on in the classroom- irregular attendance, lack of motivation, no application among kids."(Cathy, New South Wales)

"Research results are rarely functional in, or applicable to, real classrooms. "(LeCompte & Preissle, 1993, p. 355)

"Most educational research is perceived by teachers (mathematics) as irrelevant to their daily working lives." (Cochran-Smith & Lytle, 1992.p. 304)

The claims above are further supported by Bell (1998), in her discussion of issues on research development in science education. She mentions that teachers are often frustrated that after attending in-service courses or professional association meetings, or studying for university qualifications, they still feel unable to use the new teaching activities, curriculum materials or content knowledge to improve the learning of their students. Hence she said that the nature of teacher development and the factors that help or hinder it are of interest to people who want to introduce improvement in science teaching. In our viewpoint, such intervention programs are likely to be faced with criticism as described above unless informed by research.

As far as teacher learning is concerned, Putnam and Borko (2000), emphasize the importance of the situative approach to teacher education**, "the physical and social contexts in which an activity takes place are an integral part of the activity and that the activity is an integral part of the learning that takes place within it"(Putnam & Borko, p. 4, 2000)".** It has become essential to find out what activities are taking place in schools. Brown (1989) and his colleagues define activities called "authentic activities" (activities that are similar to what actual practitioners do), as the "ordinary practices of culture". It is this ordinary practice of the schools that are occurring within the context of the school that we are interested in exploring.

It is against this background that this paper establishes classroom activities that will inform intervention that is relevant and lifelong. This will also inform where and how intervention should be focused. In our view this paper will reveal useful research direction in mathematics teacher education professional development.

Aim

This paper presents an analysis of field notes observations of ten secondary teachers of mathematics in three township schools.*(Township schools are schools that are located in semi-urban areas that were demarcated only for blacks.)* This was done with the purpose of establishing teachers' classroom practice that is, activities done by teachers in their classrooms including teachers' knowledge of teaching styles, content knowledge, overt professional attitudes, and classroom management. The study is still in progress. The data presented in this paper marks the first research activity of a study that will collect baseline information of secondary mathematics teachers' classroom practice using other methods such as interviews and questionnaires.

Methodology

The research method was qualitative. Ten teachers in three schools were observed in their classrooms by the first author. Observations were recorded in the form of field notes. Reflective notes that served as a record of personal thoughts such as speculations, feelings, problems, ideas, impressions, descriptions of what is observed, quotations from people

observed, insights and interpretations were written (Bodgdan & Bicken, 1992). A total of twenty-one lessons were observed. The role of the observer was to record information as it occurred, to understand and learn as much as possible about the teachers' classroom practices.

Sample

The sample was chosen from one township in Gauteng Province that was close to UNISA in consultation with the education department and on the recommendation of the education district official and willingness of the school principal and the mathematics teachers. Ten secondary mathematics teachers of grades 10 -12 in three schools in Gauteng Province were involved in this study.

Data analysis

Data analysis was guided by data analysis procedures that are used in qualitative design. According to Tesch (1990), the process of data analysis is *eclectic*; there is no 'right way'. In this report, data analysis entails an examination, interpretation and synthesis of field notes records discovering of patterns, ideas and understandings. Categories of classifying the data were allowed to emerge from the data.

Findings

Teachings styles

With regards to the teachers' methods, classroom observations revealed that generally the teachers spend much time writing down solutions to problems on the board for learners to copy, there is lack of individual attention to the learners, verification of whether learners' answers were correct, teacher pupil interaction, group discussions are absent although learners are seated in groups during class periods. There was lack of questioning approach. Very limited use of examples, especially in grade 12, use of talk and chalk method which did not allow learners to think, shallow and hurried explanations were evident in observed lessons as in some of given examples.

As I looked into learners' books I saw from what they wrote and on their faces that they were completely lost. For example, in a grade 10 lesson, to factorize, 2x + 2y, the learner wrote, 4xy.

In another problem, learners in grade 10 were asked to solve for r, and the learner wrote:

$r = \frac{E}{R+r}$

$R \times \frac{E}{R+r} = e$

$\frac{r \times E}{r\ r} = e$

$r = \frac{e}{} - R$

E

All the other sums of these learners that I sat close to were also wrong. More information will be found through checking learners' homework and class workbooks. These problems were not followed up.

> '*I felt that much could have been achieved if these problems were discussed in class on the chalkboard'*.

Since from my observations the majority of the teachers do not pay attention to individual instruction, these kinds of problems like the one mentioned above are not followed up.

One other observation is that even though learners were supplied with textbooks they do not bring them to class. This observation happened in all the schools. In one of the discussions that I had with some of the teachers they said that learners do not bring their textbooks to class because they fear that the books might get lost or stolen by other learners.

One of the field note record read as follows:

> *"No one has a textbook in this class. All learners have taken out their notebooks. They are copying form the chalkboard. As the teacher talks learners are also adding and responding in chorus. Completing sentences as he spoke."*

As a result the teachers generally write all the sums on the chalkboard and give homework orally. These problems might also be compounded by the fact that the problems might be copied wrongly.

One of my field notes reflections read as follows:

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> *" As he writes I thought that the teacher does not seem to mind whether learners have done their homework or not or whether they understand or not.*
>
> *The teacher seem to be talking to one or two learners in front who seem to understand I think"*

As he explains to those who seems to understand the teacher says:

"Ba tla le tshwara ko tseleng"(They will catch up with you along the way)."

Here follows an example of one problem done in a lesson on simultaneous equations in grade 11. The problem was, solve: $3x – 4y = 7$ and $2x^2 + xy + 3y^2 = 4$

Unproductive questioning went on before the learners could come up with the quadratic formula. Some of the questions that transpired to solve the equation, $71y^2 + 133y + 62 = 0$, which come from solving the simultaneous equations above, were as follows:

T: What are we determining? How are we getting it?

L: (One learner answers), Quadratic formula.

T: Do you know quadratic formula? I doubt.

L: (in chorus), Ja, ra itse (Yes we know)

T: Ke ilo botsisa yo mongwe le yo mogwe.(I am going to ask each one of you). Wa itse…((Do you know)? Teacher points chalk at the board for one minute waiting for learners to respond. You wrote it

in the assignment. O e lebetse? (Have you forgotten it?) Ga o itse. (Don't you know?) O e lebetse?(Have you forgotten it?). Tla ke go utlwe (Let me hear you). O a itse wena? (Do you also know it?) Le wena o lebetse? (Have you also forgotten?)

The teacher counts 4, 5, etc. (He is asking and pointing at each learner).Then teacher approached a group of learners who did not submit their assignment and told them that they did not submit the assignment. It seems that in that group the assignment was supposed to have been written by one learner. This learner was not present when the work was handed out.

T: E ngwetse ke wena? (Did you write it?)

L: (The one who according to the group was supposed to have written it, apparently she is the one who knows the work replied), Ha ba e tlisa.(They did not bring it).

For about 6 minutes the teacher was asking, these kind of questions

T: Wa itse? (Do you know?) You are looking at the book. Tell me what is it?

L: x = y

T: Shut up you will soon catch cold.

Finally another learner gave the quadratic formula.

T: E feletse. Ke quadratic formula e. Ke lanhla le e bona.

(The period is over. The teacher leaves learners to finish substitution on their own.)

T: Ke mmereko wa std 2 (Grade 4). Le tla re ha ke le phasisa la re ke a le hlolla.

(I am not sure what it means. I guess he means that, because the work is so easy if they pass they will think that it is unfair).

An example from filed notes with regard to teachers writing down answers for learners went as follows:

A ke re le a itse ke ngwala dianthsara. …..(isn't it you know that I write answers)

He writes the answers next to the sums

1. 3
2. –4 initially he wrote 4 not –4
3. 6x – 2

He explains the last one. Learners ask him to do all of them. He does it on the board

He writes the formula and works out. All the sums have now being done for learners. There was no follow up on whether learners got the sums right or emphasizing particular problems.

Another record went as follows:

At 9h43 the lesson started instead of 9h30

The teacher without saying a word begins to write solutions on the chalkboard. He has a piece of paper in his hand. The girls are copying. I do not see any boys in this class.

9h45: Two girls enter as he continues to explain. He has drawn a diagram on the chalkboard. I could not copy it) He explains looking at the diagram and also uses colored chalk.

"I thought that was good when he used color to emphasized his point".

Some learners are giving answers from calculating on calculators. Without calculators learners are stuck. Others are busy copying from the board and from their colleagues' exercise books.

9.50 One boy enters. There is now 16 girls and one boy. Other learners did not come. The teacher is not paying any attention to him. He continues to write. Gradient of parallel lines. Very little talking is going on.

"As he wrote down the answers I felt that he is doing too much for the learners their work is just to copy. I was also trying to copy down what he was writing. The chalkboard needs a wash with water. It does not leave even after he cleaned it."

Content knowledge

As far as content knowledge is concerned, there was evidence of lack of teachers' basic conceptual knowledge that often left learners confused. In a grade 12 lesson, for example,

one teacher wrote $y = m^{-1}x + c$ and $y = m^{-2}x + c$ in a lesson on gradients of parallel lines. This is not only confusing but does not comply with standard notation of gradients. In one other lesson the x- and y-intercepts were represented respectively as x (-x; 0) and y (0; 1), this is not the right way of representing the x and y coordinates.

Lack of confidence in the subject content is illustrated in what transpired in a grade 12 lesson when the teacher was explaining how to determine the 5th and 8th term of a geometric sequence 9; 3; 1... The record is as follows:

$T^5 = ar^4$ $r = T^2$

T^1

$= 9(\frac{1}{3})^4 = \frac{3}{9}$

$= 9(\frac{1}{81}) = \frac{1}{3}$

$= \frac{9}{1} \times \frac{1}{81}$

$= \frac{1}{9}$

Next he writes,

$T^{n} = ar^{n-1}$

$T^{8} = ar^{7-1}/^{8-1}$ this was left on the board

$= 9(\frac{1}{3})^{7}$

$= \frac{9}{1}$ X (2187) this mistake was not discovered

$= \frac{1}{243}$

Later he wrote 8-1.There is a debate on whether to write 7-1 or 8-1

He then explained using the formula for the nth term. He ultimately writes 8-1. Some learners after the explanation remarked that he did not tell them that it was 8-1. Some said, "ha re utlusise" (we don't understand) from their seats.

'I felt he did not emphasize or clarify the cause of the confusion.'

As he teaches he is holding a book in his hand. When he made a mistake he said it is the chalk, which made a mistake. During the argument every one is shouting at the top of their voices. The teacher seems not to mind. It seemed things were out of control.

He thought that he made a mistake. Then he writes;

$T^{5} = ar^{4-1}$

$=9(\frac{1}{3})^3$

$=9(\frac{1}{27})$

$=\frac{1}{3}$

I thought to myself that he could have written the formula first for the benefit of learners.

Again he writes

$T^5 = ar^{5-1}$

$= 9(\frac{1}{3})^4$

$=9(\frac{1}{81})$

$=\frac{1}{9}$

He determined the 5th term 3 times. He did not explain the cause of the confusion. *I wondered whether learners were following. I felt that he should always write the values of a and r*

Then he gives another problem.

Determine the 4th and the 6th term of the following 2, 6, 18, 54

T: Re thoma ka ho reng? (*How do we start?)*

Learners answer in chorus, it is difficult to hear what they say.

T: A ke re ra tshwana ba bohle (isn't it we are all alike) - in my opinion this means you and me are the same, we are not different. (*I also felt that the teacher depends on the learners*)

The teacher gets the values orally from some of the learners, while others are copying as he writes.

$T^4 = ar^3$

$= 2(3)^3$

=2X27

=54

$T^6 = ar^5$

$=2(3)^5$

=2 X 243

=486

He calculates without writing down the formula. Learners mumble, they say, "hare utlwisise" (we *don't understand).* The teacher does not address their problem .One learner refers the teacher back to the previous problem. Apparently he did not understand how the solution to $\frac{9}{1}$ X 2187 was found. This problem was still on the chalkboard.

The teacher explains about how division was done using the same example, which was still on the board, but the mistake was not erased even after the explanation.

Then he moves on to the next section.

"Bjalong re ka etsa simultaneous equations". (Now we can do simultaneous equations). "Re na le period e one". (We have one period). Learners mumble it seems they needed more examples. He says "Le mphosolle ha ke na le phoso. Re tlo rutana. A kere."(Correct me when I make mistakes, we have come to teach each other, isn't it*)*

He then continues and writes,

Determine the Geometric sequence with 2nd term = - 4 and 5th term = $\frac{4}{125}$

He is taking this sum out of a textbook I do not see any textbook on the learners' desks. He starts writing,

$T^2 = ar^1 = -4$ …. (1) Ba re file eng? He writes and talk, learners completes

$T^5 = a\,r^4 = \frac{4}{125}$ …(2)

Eq. (2) ÷ (1)

$$\frac{ar^4 = \frac{4}{125}}{ar^1 = -4}$$

T: Ge re devida re irang ka exponent? (When we divide, what do we do with the exponent ?)

Some learners answer in chorus. "Ha re devida ra subtract ha re multiplaya ra eda". (When we divide we subtract, when we multiply we add).

One learner volunteers to do it on the chalkboard but fails.

The teacher erase quickly. I could not take down what he wrote. The teacher takes over and writes without leading the learner to think about how to do it,

$$r^3 = \frac{4}{125} \times -\frac{1}{4}$$

$$= -\frac{1}{125}$$

$$= 5^{-3}$$

$$r = -5$$

Some learners look puzzled; they seem not to understand why r is – 5.

The teacher says it is exponents. One learner seemed completely lost and asks what they were doing. The teacher said that it is simultaneous equations for example, he explained,

T:Simultaneous equations re a di kopanya (simultaneous equations we combine them). He ba re file two equations re berekisa simultaneous equations (when we are given two equations we use simultaneous equations), 1st equation divided by 2nd equation (this is the end of the explanation to a learner who said he does not understand what the teacher was doing). He continues with the lesson.

H Re na le *r*, re nyaka *a* use any equation.(We have *r* we want *a* use any equation).

He writes

*a*r = - 4

a x - 5 = - 4

- 5a = - 4 He gets confused learners help out.

$$\frac{-5a}{-5} = \frac{-4}{-5}$$ Re devida ka – 5 (We divide by –5), they said.

$$a = \frac{4}{5}$$

He substituted with that wrong value of *r*. Some learners say " Sir ha re utlwisise a re ireng le ko (2)" (Sir we don't understand let us substitute also in equation 2)

Then he writes,

$$a\underline{r}^4 = \frac{4}{125}$$

$$a(-5)^4 = \frac{4}{125}$$ Some learners are watching

$$\frac{625a}{625} = \frac{4}{125} \div 625$$

There is one active girl and she said teacher, "mo kare re irile mistake" (it seems we have made a mistake here)

$$a = \frac{4}{125} \times \frac{1}{625}$$

One learner said that when she worked it out she got 20. Another learner said: "Sir lebella answer ko bukeng".(check the answer in the text book). Some said, "Sir, we will do it later". He wipes off and writes again.

$$a = \frac{4}{125} \div \frac{625}{1}$$

$$= \frac{4}{125} \times 25$$

= 20

He senses something is not right.

Again, the teacher writes:

$r^3 = 5^{-3}$

r = -5

He says, "the mistake is with the sign". He looks puzzled. "Le tla e thoma ka bosiu".(*You will start it tomorrow*)

Again the T. writes,

ar = - 4

$\frac{1}{5}$ a = - 4 I don't know where he got $\frac{1}{5}$ (probably he checked from the textbook)

$\frac{1}{5}$ .a = - 4 x 5

a= 20

He ignored the minus sign. *I thought that he new the answer was supposed to be 20*.

After writing the answer, the teacher left. The learners said, "Sir, o siya mam". (you are leaving mam behind)

> *"I felt that the teacher was unprepared. I also felt that the teacher seemed not to be very confident about the subject matter and that learners are feeling sorry for him because they said that he should check the answer in the textbook. And also that they will do it on their own."*

Overt professional attitudes

As far as observed professional attitudes are concerned, lack of lesson preparation was manifested in different ways as for example in the example above a right answer was given when the calculation was not right. There were several incidents of teachers coming to class late for lessons in almost all the schools (10-15min.), leaving learners unattended during class periods, teachers being reluctant to get to class and sitting in the staff room or standing in the foyer on their way to class, ending lessons hurriedly and covering little work in a class period.

A scenario of what transpired in a last period of the day;

" It was 13h30 as I walked with Mr. X from his class. As we stood outside talking there was almost no teaching going on in that last period. We could hardly hear each other as we stood outside the classes. The learners were talking at the top of their voices in the classes and on the veranda. I witnessed one teacher going into a class, I think for something like

5min. He came out. Learners followed him out (I think he expected them to be in class). When he looked back, he saw them standing outside. He was holding a textbook in his hand. He turned back to them and told them to go back to class and then he went to the staff room."

Classroom management

Learners come to classes late. During class periods, they move from one desk to another, talk to friends. Some read magazines, others do work of other subjects during the Mathematics lesson, still others sleep in class on desks, learners polish shoes, etc. the teacher does not respond to any of these.

Miscellaneous

Generally, towards examination time teachers leave classes unattended to finish examination setting of papers. Organizing for printing exam papers, sorting out venues etc.

When teachers attend meetings classes were set on hold, when there is no water in the school premises, learners were dismissed. Teachers do not inform learners of their absence from work or class.

During class learners ask for stationary from friends as for example a rubber, a pencil or a calculator, move to a colleague ‘s desk to do a calculation, take a friend’s book and copy, use pencils to as rulers,

Limitations

The data in this research has been collected by means of classroom observation only this might have researchers’ bias. This research lacks the voice of the teacher hence teachers do not have an account for the actions they make.

Implications

Observing teachers in their classrooms is sensitive. Teachers’ classroom practices might be influenced by the presence of the researcher. Nonetheless, the results revealed so far from classroom observations have shown that there are problems with secondary mathematics teachers’ classroom practice. The aim of observation was to observe classroom practices of secondary mathematics teachers; it is interesting that these observations yielded information about the teaching approaches, the teachers’ content knowledge and professional attitudes. So it is not just the classroom practices that need changing, but also all the other dimensions. There is therefore a need for teachers to be helped with teaching styles, professional attitude, classroom management and content knowledge. More information will be found through in-depth interviews.

Conclusion

This paper established baseline information for the professional development of secondary mathematics teachers within the South African context. Identified the need for professional development, emphasized the importance of relevance of intervention programs and the value of the situative approach to professional development. Clearly, the analysis of classroom observations has given us insights to teachers’ classroom practices by providing baseline information on the teaching styles, content knowledge, and overt professional attitudes of mathematics teachers. Based on this results strategies will have to be devised

as to how to provide professional development intervention for these mathematics teachers in a holistic way.

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