Impact of University Lecturers' Intervention in School MathTeaching

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Some schools in the neighbourhood of Sefako Makgatho Health Sciences University (SMU) in South Africa persistently yielded poor mathematics results in the past years. This was of concern since maths is the main subject for many opportunities, including admission to SMU study programmes. Some SMU maths lecturers partnered with local schools to prepare the students in these schools. The aim was to improve maths teaching and matric maths results. The teachers were assisted with maths concepts of most difficulty. This article describes the initiatives by some academics of SMU in achieving this.

1. Introduction

SMU is a university at Ga-Rankuwa township in the Gauteng Province of South Africa. It offers limited Bachelor of Science (BSc) degrees in the natural sciences. The students of SMU mostly want to pursue medicine. Those who do not qualify due to low matric maths marks join the sciences. The sciences therefore found it difficult to grow, mainly in research output. Also, the retention of good science students was minimal because SMU did not fund the sciences as well as it did the health disciplines, and less than other similar institutions. So, the pass rates were generally low, and dropout rates also unfortunately high. Hence, science academics took it upon themselves to promote their departments, while many others left SMU in search of better prospects. So, the mathematical science (MS) departments in SMU were losing top students and attracting students with limited maths capabilities.

An initiative to understand major problems in teaching of maths in nearby secondary schools was embarked on by some con-

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Intervention, maths pass rates, support.

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cerned SMU maths academics. The intent was to reduce those problems where possible, and to prepare learners (students) to the maths degrees in SMU and other institutions of higher learning. 'Action research' was used because according to [1], it is about understanding of practice, the situation in which the practice takes place, and then ultimately leading to improvement of practice.

These volunteer academics of mathematical science departments were committed to help the students coming from poor socio-economic backgrounds to complete their degrees within the stipulated period. They formed a help group to assist local schools to improve maths teaching. They also exposed the teachers to some necessary maths concepts. They targeted the needy teachers, and agreed to take on minimal teaching of the concepts which teachers did not know well.

The aim of the study discussed in this article was to equip matric maths teachers where they lacked in content, show the extent to which they benefited, and determine how the matric maths results were affected.

2. Methods

The research started by identifying local secondary schools that were producing poor matric maths results. Fourteen (14) schools were confirmed to have consistently produced poor results (<50% pass rate) for at least three years in the past five years. They involved 34 teachers. In a 5-year stretch from 2009 to 2013, the study determined these teachers' qualifications, and the content of the maths courses they were taught either at school or at teacher training.

Teachers and learners stated the maths topics that they found difficult. Then the volunteer academics were assigned to teach these topics to the teachers, and also to the learners. The volunteer drill sessions with the teachers strictly excluded the learners, but the teachers were asked to observe when the learners were taught. This article analyses the effect of these interventions.

2.1 *Research Design*

This study used exploratory research, i.e., research conducted to gain an understanding of a new problem that has not been done before [2,3]. In this study, the weak points of maths teachers were investigated. Then the methods of assisting these teachers to acquire the needed skills and knowledge were explored. The objective of the exploratory research was to identify key issues and key variables, such as level of interest in being assisted to attain the required skills and knowledge, and strategies to help the teachers to obtain these. After identifying poorly performing schools, the teachers and the principals of these schools were approached with a proposal to assist them. The difficult sections in the syllabi were identified by the teachers, and also by the learners separately.

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Students who were already at universities, and had attended the same schools, were also asked to mention the topics that they struggled with while at school. This study was exploratory research to develop a list of problems and their possible causes.

Exploratory research can uncover possible opportunities for designing strategies to help the teachers. Developing a list of realistic strategy options might first require exploratory research [4]. Once developed, a formal study can identify the option that is most likely to reach the teaching objectives. Moreover, exploratory research answers questions about complex research problems. The academics can also get a sense of how best to reach the respondents (teachers). This approach has an action research portion, which emphasizes that the researchers determine the strengths of their initial position, and how best they can effect change by learning and researching for the practice they want to improve [5]. Thus, the researchers who wanted to help the teachers gauged themselves first for the tasks, improved upon their skills and only then they interacted with the respondents in the local secondary schools.

The poor quality of students had led SMU to introduce a four-year option for a three-year degree for students with potential but who did not fulfil the basic requirements. They were given bridging courses as extra support to reach the level prescribed for straight admission.

2.2 *Respondents*

The study used the respondents (i.e., maths teachers) who were producing poor maths results at matric level. It focused on teachers who were committed to teaching, willing to improve but on their own not being able to obtain the high levels of results they wanted. Those who were not producing desirable matric results but not willing to participate were left out. A sample of 76 individuals (29 teachers and 47 students) participated over a period stretching from September 2009 to October 2013. The analysis was carried out in June 2014.

2.3 *Role Players in the Research*

The primary participants were 29 teachers, 47 university students, and the researchers (academics). The poor quality of students had led SMU to introduce a four-year option for a three-year degree for students with potential but who did not fulfil the basic requirements. They were given bridging courses as extra support to reach the level prescribed for straight admission. Of the four years, the first year was to enable such students to fulfil the minimum requirements for admission to the BSc programme.

The researchers (trained maths teachers and practicing maths lecturers at SMU) became interviewers as they were all qualified and understood basic and applied research, and knowledgeable in research ethics. They were familiar with the geographical areas in which the research took place, and had a good understanding of the languages and cultures of the communities in the study area. They interviewed the willing participants at the latters' convenience.

2.4 *Research Instrument and Data Collection*

The data collection took place in two stages. The first was to determine teacher profiles and their familiarity with maths topics before intervention. The tool used was a closed-ended questionnaire for the teachers which included their qualifications and the

difficult maths topics. Particularly, the tool was focused to determine the years of experience, and whether the teachers knew the topics of the entire syllabus. Teachers could leave the programme when satisfied with the knowledge they acquired, or for any other reason. At various stages, checks were made to determine if the teachers understood the topics they initially did not know. After the 4-year intervention, another data collection was carried out through interviews. This was to gauge if the efforts introduced for the teachers' improvements had been effective. It consisted of face-to-face interviews to enable probing when a need for clarification arose. The teachers gave feedback on their understanding of the topics they were taught.

2.5 *Data Handling and Analysis*

Initial responses (i.e., raw data) were collected using Microsoft Word, while Excel spreadsheets were used to capture numeric data. SPSS[1] was then used to perform the analyses. Data analysis consisted of organisation using tables, graphs, and some chi-square tests. Graphs were used to gauge the level of teacher improvement in the schools that participated, and whether the number of maths passes were improving in these schools.

[1] SPSS is a software used for statistical analysis. It denotes for Statistical Package for Social Scientists.

3. Results

All the teachers were qualified professionally (see *Table* 1). Nine (31.0%) of them had three-year college diplomas, eight (27.6%) had one-year university postgraduate (PG) teachers' diplomas after completing three-year university degrees, seven (24.1%) had three-year degrees completed after three-year college diplomas, and five (17.2%) had PG degrees with three-year teachers' diplomas.

Table 1. Qualifications of educators. ('A' refers to 3-year college diploma.)

Highest qualification	3-yr college diploma	3-yr univ deg + 1 yr HDE	3-yr degree + A	PG + A
Frequency	9	8	7	5

Topic	Calculus	Statistics	Trigonometry	Financial maths
Frequency	8	7	8	6

Table 2. Syllabus topics of difficulty for teachers.

Four topics (*Table* 2) were identified by most teachers as very difficult for them. However, only the topic of most difficulty for each teacher is considered here. Eight (27.6%) teachers struggled mostly with calculus, seven (24.1%) with statistics, eight (27.6%) with trigonometry and six (20.7%) with financial maths.

The learners also identified the most difficult topics which were the same as those of the teachers. Also, only the topmost topic in terms of difficulty for each learner is shown in *Table* 3. Twenty-eight (36.8%) learners struggled mostly with calculus, nineteen (25%) with statistics, twenty-one (27.6%) with trigonometry and eight (10.5%) with financial maths.

The hypothesis being tested was that the difficulty levels of the various maths topics were independent of whether it was the teacher or the student involved. In order to determine if it fitted the proportions, a goodness-of-fit test using chi-square was applied. The null hypothesis being tested and the alternative hypothesis were given by respectively:

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H_0 : Maths topic difficulty is independent of whether a teacher or learner is involved.

H_a : Maths topic difficulty depends on whether a teacher or learner is involved.

The observed frequencies are shown in *Table* 4 and the expected frequencies in *Table* 5.

The value of the χ^2 test statistic [6] is (where o_i and e_i are respectively the observed and expected values):

$$\chi^2 = \sum_{i=1}^{k} \frac{(o_i - e_i)^2}{e_i}$$
$$= 22.7629$$

Topic	Calculus	Statistics	Trigonometry	Financial maths
Frequency	28	19	21	8

Table 3. Syllabus topics of difficulty for learners.

Topic	Calculus	Statistics	Trigonometry	Financial maths
Teachers	8	7	8	6
Frequency	28	19	21	8

Table 4. Syllabus topics of difficulty.

Topic	Calculus	Statistics	Trigonometry	Financial maths
Teachers	18	13	14.5	7
Frequency	18	13	14.5	7

Table 5. Expected frequencies of difficult topics.

The value of the degrees of freedom (d.f.) of this test statistic is $k - 1 = 4 - 1 = 3$. From [7], the critical value at 5% level of significance with 3 d.f. is $\chi^2_{0.05} = 7.815$. The test statistic exceeds the critical value, and hence, the hypothesis of independence should be rejected. Thus, the topics of difficulty trouble the teachers and the learners in different ways.

Only three (10.3%) teachers had not been exposed to the topics they found difficult, during their teacher training or school days, while an overwhelming 26 (89.7%) had been exposed to those topics before (see *Table* 6).

Table 7 shows the number of teachers having different years of teaching experience. Assuming these are proportional to ages, there is a chance for succession planning to offset maths teacher shortage when older ones retire.

	No	Yes
Frequency	26	3

Table 6. Teachers exposed to difficult syllabus topics before.

Topic	< 5	[5 10)	[10 15)	[15 20)	[20 25)
Frequency	3	4	6	9	7

Table 7. Years of teacher experience.

	No	Yes
Frequency	9	18

Table 8 (left). Teacher familiarity with all syllabus topics (before).

	No	Yes
Frequency	25	3

Table 9 (right). Teacher familiarity with all syllabus topics (after).

Nine (31.0%) teachers indicated that before the intervention programme, they were familiar with all the topics of the maths syllabus, while 18 (62.1%) were not familiar with the topics (*Table* 8). The other two (3.5%) did not respond.

At the end of the intervention programme, 25 (86.2%) teachers indicated that they had become familiar with all the topics of the maths syllabus, while three (10.3%) were still not familiar with the topics (*Table* 9). Two (3.5%) did not indicate where they belong.

The increase in observed frequencies from 'before' to 'after' intervention is an indication that the intervention was effective. The teachers became familiar with the four topics in the matric maths syllabus which they had earlier indicated to be very difficult for them. Teachers had not done topics in calculus, matrices and statistics during their school days and their teacher training. Hence these topics were difficult.

The learner performance trends of the seven participating schools since intervention started are shown in *Figure* 1.

The increase in observed frequencies from 'before' to 'after' intervention is an indication that the intervention was effective. The teachers became familiar with the four topics in the matric maths syllabus which they had earlier indicated to be very difficult for them.

According to the graphs, schools 1, 3 and 5 showed improvement in the matric maths results while schools 2, 4, 6 and 7 did not show any improvement. However, close observation shows that those not showing improvements were having pass rates of over 60% already, whereas the other ones were having lower than 50% pass rates. It shows, therefore, that the program was more suited for schools that had lower than 50% maths pass rates.

4. Discussion and Recommendation

4.1 *Discussion*

The action research approach was important, since it helped the

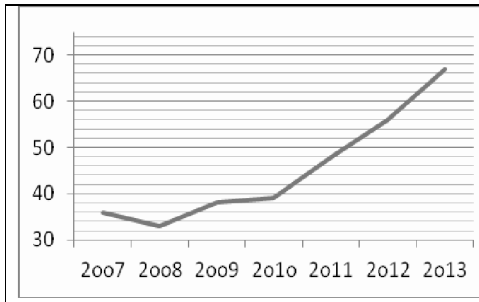

Fig. 1(a) trend for **school 1**

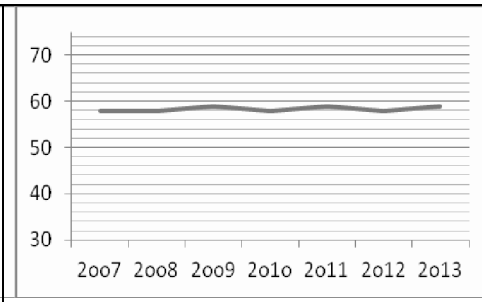

Fig 1(b) trend for **school 2**

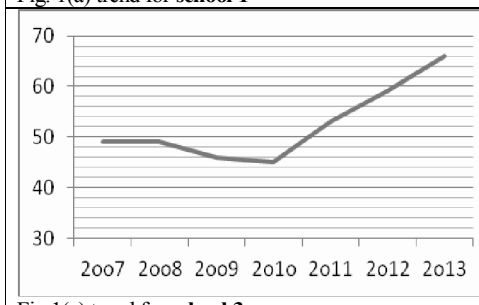

Fig 1(c) trend for **school 3**

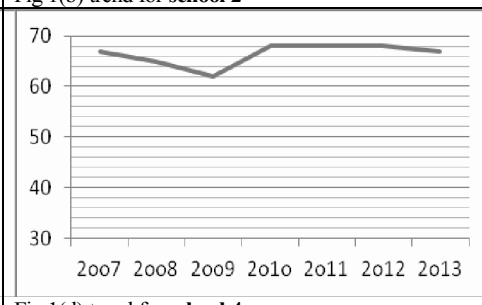

Fig 1(d) trend for **school 4**

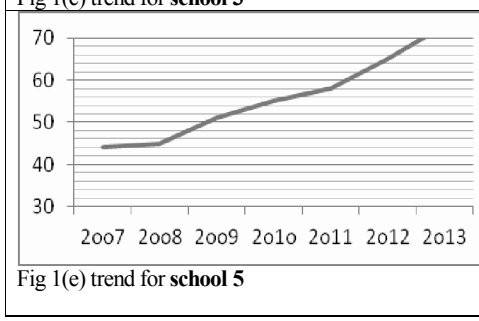

Fig 1(e) trend for **school 5**

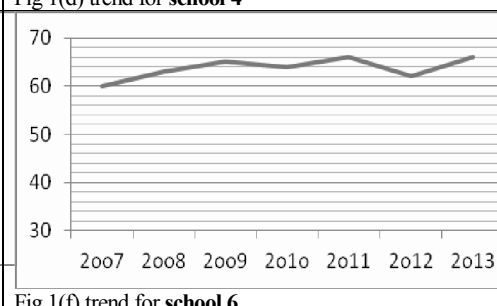

Fig 1(f) trend for **school 6**

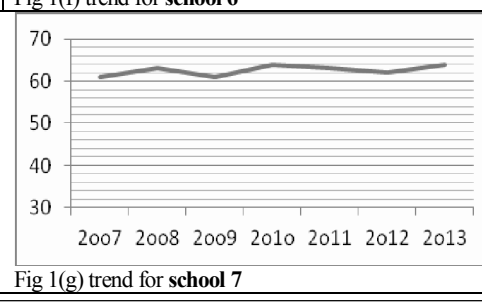

Fig 1(g) trend for **school 7**

Figure 1. The learner performance trends of the seven participating schools after intervention in maths teaching.

researchers to understand the teachers needs in order to address the problem. There were improvements in teacher skills and higher passes for the learners. Teachers indicated to have improved, and statistical tests showed that the intervention indeed increased teachers' skills levels. Even in topics where the teach-

Collaboration between the school teachers and the university academics in maths showed that the lecturers were able to equip the teachers with the necessary skills for maths teaching.

ers were deficient, evidence showed that the teachers still understood the topics more than the learners. This is desirable since the learners would not find reason to undermine or disrespect their teachers. The problem is that the teachers were not fully equipped to stretch the learner's knowledge to reasonable limits. It would have been worse if the learners were at the same level as their teachers, or even better than them. It also gives hope and the impression that the teachers would then grasp the topics ahead of their learners in these interventions.

Collaboration between the school teachers and the university academics in maths showed that the lecturers were able to equip the teachers with the necessary skills for maths teaching.

4.2 *Recommendations*

It is recommended that:

- Intervention programmes should be
  i. extended to schools of the districts in the jurisdiction of SMU that are far away from the locality of the campus, such as the rural areas where there are no tertiary institutions; and
  ii. improved to be effective even for schools that have high (but less than 100%) pass rates.

- Dialogues should be sustained between the academia and teachers in schools on developments during syllabus and curriculum changes at tertiary and school levels. Collaborations are needed between teachers and academics, especially where teachers are never exposed to university education. Maths lecturers' involvement in schools can ensure that school teachers know the learner requirements for university studies in the sciences. They can assist in making them capable of preparing the learners adequately.

5. Conclusion

In this study, seven schools participated from 2009 to 2013.

Intervention of the researchers showed to be effective only for the poor performing schools. Those with descent pass rates of over 50% did not benefit from it. This was the sign of lack of optimality in the methods used. The research recommendations suggested that intervention methods should be improved to be effective in all schools, and extension of the endeavours to more schools.

Suggested Reading

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