

Social Responsibility in Augmenting High School Maths Learning for University Studies

Joel Lehlaba Thabane and Solly Matshonisa Seeletse

Department of Statistics and Operations Research, Sefako Makgatho Health Sciences University, PO Box 107, MEDUNSA, 0204, South Africa

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ABSTRACT Sefako Makgatho Health Sciences University (SMU) is a university in South Africa launched on the 1st of January 2015. Its students come mostly from poor families in under-resourced South African living areas. A decent pass in matric mathematics (maths) is the main criterion for admission into SMU programs. However, maths pass rates are habitually low. In attempting to improve matric maths passes, some SMU maths lecturers undertook a study to uncover the bases of problems. The study objective was to determine why matric maths passes were low, and what interventions could be effective to improve matric maths performance. The lecturers then offered intervention maths classes to local schools, teaching some maths areas. The study identified the toughest maths areas, and the teachers' training deficiencies. The intervention was effective only for schools with poor results. This signaled sub-optimality of the interventions. Improvements on the intervention methods were recommended.

INTRODUCTION

Some students of SMU do not have financial support. Many of them apply to study at SMU in the health science programs. Excuses often arise from students who underperform in study programs in which they lack interest (Holmes et al. 2017). The case of SMU is not excluded. Many SMU students who are registered for the natural sciences programs did so in order to apply in later years for enrollment in the health science study programs. Their matric pass rates were commonly low for admission, either absolutely or when compared with top performers. The rates of dropout for students who came with low matric passes were also exceptionally high. In the maths discipline, the low passes were often said to be due to poor matric maths background (Bossér and Lindahl 2017). The difficulties recognized with the SMU students were lack of computer knowledge, inexperience with the (modern) library, inadequate study methods, ignorance about careers, poor lecturer performance in presenting the science subjects, pressure of parents and other people, and campus excessive support of the health science against medicine focus at SMU management level. However,

mathematics is an essential subject (Mason 2007). The SMU lecturers from mathematics and statistics departments decided to assist to educate maths educators and their learners at school level. Some lecturers established a support group for backing schools local to SMU to advance the teaching of maths. This support group also showed the maths teachers some facilitation methods and difficult areas in maths. Even though the support group had targeted to improve the teachers with their initiative in the long term, for the short to medium terms, they taught maths concepts which troubled the teachers.

Study Purpose

The study aim was to expose schools on methods to improve maths pass rates at the high school level. The objectives were:

- ♦ To determine what could assist school teachers to improve their maths teaching; and
- ♦ To identify maths areas of most difficulty for both the learners and their teachers in order to improve pass rates.

Literature

The study was a social responsibility initiative conducted through action research to iden-

Address for correspondence:
Telephone: +27 12 521 4291,
E-mail: solly.seeletse@smu.ac.za

tify problems in secondary schools concerning maths teaching at matric level. The long-term goal was to design a befitting solution for improving maths pass rates to aid learners who plan to enroll later at tertiary education level. The general aspiration was to improve the quality of lives of community members, and increasing matric maths pass rates was viewed as a contribution. Consequently, the foremost study areas were action research and social responsibility that appear below.

Social Responsibility

Social responsibility intends to advance society (Raynard and Forstater 2002). In business, it drives corporates to digress from exclusively concentrating on profit making to support environmental and lawful codes for community fortification and progress. Social responsibility is therefore an enterprise's thoughtful principled initiative that would go a long way to improve society. Ladzani and Seeletse (2012) endorse this notion by attesting that social responsibility is voluntary and charitable. There are companies with no courage to embrace activities of social responsibility. The social responsibility leaders are enterprises that can influence stakeholders to espouse means for social development and design tactics towards quality sustainable development (Nguyen et al. 2009). Supporters of social responsibility tend to develop an effective framework for measuring and monitoring the social responsibility impact on the environment, communities, consumers, employees, and stakeholders, among others. They basically evaluate the benefits to these stakeholders. Thus, social responsibility consists of management values and principles for guiding moral relationships with communities, improve sustainable development through conserving accessible resources for upcoming generations, valuing miscellany, and decreasing social disparities, among other initiatives. Consequently, concepts reinforcing social responsibility include 'ethics', 'campaigns to reduce social inequality', 'commitment', 'relations', 'social accountability', and 'sustainable development'.

Ethics

Ethics entails principled values that are vital for augmenting social responsibility. According

to de Oliveira (2003), ethics are indispensable philosophies for the activities and dealings with all institutional stakeholders. These basically refer to moral principles that govern behaviour and actions (Amit and Schoemaker 2013). Ethics is therefore, a fundamental concept, and also a major constituent of social responsibility.

Commitment

Commitment is mainly a careful intrinsic pledge to do something. Even when persuaded by an external advise, the final decision to commit comes from inside. Seeletse and Ladzani (2012) revealed that lack of commitment may lead institutions to unsettle institutional growth and reduce competitiveness. Organizations that embrace and implement social responsibility initiatives do so because of their commitment and not because of being coerced. Some organizations know about social responsibility, but do not embrace it in their activities because of lack of commitment to it.

Dialogue

Dialogue is the exchange of thoughts by communicating among various parties (Keh et al. 2006). In communicating, it is imperative that people identify a common understanding and goal. Maranhão (1990) points out that company management can streamline their ideas for actions by interrelating through dialogues. Dialogue can explain the reasoning behind the ideas generated. If management is interested in embarking on a venture, they can obtain a buy-in of employees of lower ranks by using dialogue. Therefore, dialogue can heighten commitment since the involved parties can be motivated to attain the anticipated ends.

Relations

Relations entail methods in which individuals are associated. They increase interactions among diverse personalities. Healthy relationships develop when understanding and trust prevail. They are essentially established by committing to achieve a goal of common interest. Thus, relationships commence when individuals recognize each other as being possible associates to work together for desired communal

goals. Once a relationship has been formed, its sustainability depends on the yearnings to continue working together. The relationship may be ended by mutual agreement. For instance, when the parties lack common future desires, or cannot agree on common operating methods, their relationship can be ended. Relations are also terminated when conflicts transpire among the parties in a relationship.

Social Accountability

Social accountability is an essential tactic to account to ordinary citizens and civil society (Gray 2000). It transpires when an institution clarifies and justifies its vital manifestations. It stimulates poverty decline, and augments effective and sustainable advance to supply services. It cultivates governance, development and empowerment. It also endures citizen participation in crafting public policy. Thus, a socially accountable establishment poises the management of its economic and financial resources, environmental resources, and its social resources (Dey 2007).

Sustainable Development

Sustainability refers to survival that leads into a desirable future. Hence, sustainable development entails continued advancement into the future. According to WCED (1987), sustainable development refers to meeting current needs without obstructing the future generation's ability to meet their own needs. A socially responsible establishment is managed according to the pillars of sustainable development and an establishment steered by these pillars is socially responsible (Wilson 2003). Such an establishment endures its activities by managing its resources economically.

Competitive Advantage

Competitive advantage is the strategic lead that an establishment possesses over its rivals within its industry (Porter 2008). Accomplishing it reinforces and positions an organization higher in the industry. Fundamentally, an institution that has a competitive advantage implements value-creating strategies that are not concurrently applied in the enterprises of its competi-

tors (Grant 2013). An organization acquires competitive advantage by controlling the various resources which it can manipulate (Atkinson 2012). Therefore, in order to realize competitive advantage, an establishment should cultivate attributes for outstanding competitors. Examples of such attributes would consist of new technologies, highly trained and skilled human resources, among others. Organizations that have a competitive advantage could ensure their superior performance by outclassing competitors (Bhatt and Grover 2013). Superior performance is an indication of competitive advantage.

Action Research

Action research is the kind of research for improving practice by understanding the practice, and the situation in which the practice could be done (McNiff 2001). It suits conditions that involve diverse approaches to identify problems and for proposing solutions. An important feature of action research is its iterative property. Therefore, its process endures until a reasonable solution is realized by planning, acting, monitoring, and reflecting (Agyeman 2013). A challenge with action research is that it can carry on without reaching the end, as the steps continue to spiral without certainty in the solution reached (McNiff 2001). Action research relies exclusively on action learning that enables the researcher to learn and master the rudiments of an exercise necessitating responsiveness before embarking on corrective action (Kalof et al. 2008). The method is a reflective approach since the researcher addresses the study problem by first receiving training on skills to resolve the problem effectively.

METHODOLOGY

In this study, the researchers began by isolating secondary schools which consistently produced poor matric maths results in the SMU locality. This aided in determining the population size of the schools for the study. Fourteen (14) schools in the vicinity had consistently showed poor results (pass rate < 50%) for a minimum three years in the previous six years. These schools had 34 teachers of maths. In the ensuing six-year stretch, the study identified the qualifications of these teachers', and the most difficult maths areas to them.

Research Design

The research wanted to determine fitting techniques to assist these maths teachers to develop quality in their maths teaching, and to assist the learners to match the maths demands at university. This study applied exploratory research to understand a problem that was never solved before (Whitehead 2000; Nardi 2006). The maths teachers' weaknesses were then investigated. The approaches to help these maths teachers to learn the necessary knowledge and skill were also investigated.

Respondents

This study used the teachers and learners as the primary respondents to upsurge the quality of maths teaching and learning. These were the matric maths teachers whose learners were achieving below their peak performance and therefore showing poor maths results. Only the willing teachers were included. Those who produced poor matric maths results but unwilling to take part in the study were excluded. A convenience sample was used for this purpose. A sample of size 76 (29 teachers and 47 students) was involved in the intervention project over a September 2009 to July 2012 period. However, the interviews on the intervention reflection took place in June of 2013.

Role Players in the Research

The study participants at schools consisted of 29 qualified and teachers willing to participate, as well 47 maths learners. Other participants were the researchers who are highly qualified and experienced faculty members of university maths, who were concerned about the quality of maths students at SMU. Regarding the roles played in this study, the researchers taught other role players and also interviewed them later in the study.

Research Tool

Tools of data collection were a closed-ended questionnaire and an interview guide. The first tool was used twice. It was used before and after intervention. The interview guide was also used twice. First, it was used to understand issues of difficulty when the process started. Later it was used to learn the end results of the interventions.

Data Collection

Data collection consisted of stages. The first stage used a closed-ended questionnaire to ascertain teacher attributes, their expertise in maths areas prior to the remedial action and the learners' identified maths areas of difficulty. It then documented the teachers' qualifications and the maths content of difficulty in the syllabus. It also determined their years of experience, and the extent to which they knew syllabus contents. Teachers could also exit the intervention program when reaching satisfaction with the knowledge they acquired. Then, after four years, another data collection was conducted to measure if the interventions for improving the teachers' capability were effective. The stage entailed personal interviews to allow probing where it was necessary to illuminate. The respondents provided responses on their knowledge of the maths themes they initially did not master.

Data Analysis

Preliminary verbal responses generated raw data that were recorded in Microsoft Word. Spreadsheets of Excel were involved to capture numerical data. Data analyses were performed using SPSS and entailed presentations of tabular shows, graphical displays, and chi-square hypothesis tests. Graphs were also used in tracking the extent to which learner improvement took place and the teachers' maths skills advancement.

RESULTS

Teacher Profiles

Table 1 demonstrates that the maths teachers were mostly qualified in lower qualifications, and decreased as the qualification levels increased.

Table 1: Qualifications educators

<i>Paramount qualif.</i>	<i>3-year college dipl (A)</i>	<i>3-year univer degr + 1 year HDE (B)</i>	<i>3-year degr + A (C)</i>	<i>PGr + A (D)</i>
Frequency	9	8	7	5
Percentages	31.0	27.6	24.1	17.2

Tables 2 and 3 show that specialized areas of calculus, financial maths, statistics and trigonometry were difficult for both the teachers and their learners.

Table 2: Difficult syllabus areas for teachers

Area	Calc.	Fin. maths	Stats.	Trig.
Frequency	8	6	7	8
Percentages	27.6	20.7	24.1	27.6

Table 3: Difficult syllabus areas for learners

Area	Calc.	Fin. maths	Stats.	Trig.
Frequency	28	8	19	21
Percentages	36.8	10.5	25.0	27.6

The study proceeded to determine if there were discrepancies in the difficult areas between the maths teachers and their learners. The hypothesis being tested appear below

H_0 : Maths area difficulty occurs regardless of whether a learner or teacher is involved

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

Table 4 presents the frequencies that were observed, which replicates the ones in Tables 2 and 3. The expected frequencies are in Table 5:

Table 4: Difficult syllabus areas

Area	Calc.	Fin. maths	Stats.	Trig.
Teachers	8	6	7	8
Learners	28	8	19	21

The test statistic value from Bless et al. (2006) is:

$$\chi^2 = \sum \frac{(o - e)^2}{e} = 22.7629$$

The degrees of freedom (D.F.) value is $k-1 = 4-1 = 3$. Kutner et al. (2005) give the critical value with D.F. = 3 at 5 percent level of significance as $\chi_{0.05}^2 = 7.815$. The value of the test-statistic exceeds the critical-value. Therefore, the null-hypothesis of independence is rejected. The researchers conclude that the difficult maths areas distress the learners differently from the way they trouble teachers.

Table 5: Expected frequencies of difficult areas

Area	Calc.	Fin. maths	Stats.	Trig.
Teachers	18	7	13	14.5
Learners	18	7	13	14.5

Table 6 shows that most teachers had not learnt the areas they identified as difficult when they were in the teacher training courses.

Table 6: Teacher studied difficult syllabus areas before

	No	Yes
Frequency	26	3
Percentages	89.7	10.3

Table 7 shows that these teachers' experiences were from below five (5) to 25 years. Fewest teachers were least experienced at less than five years. Most teachers were experienced between 15 to 20 years. The second most appearing category of experiences were in the range between 20 to 25 years.

Table 7: Years of teacher experience

Years	< 5	[5-10)	[10-15)	[15-20)	[20-25)
Frequency	3	4	6	9	7
Percentages	10.3	13.8	20.7	31.0	24.1

Table 8 shows that prior to the remedial exercise, most teachers had no understanding of the most difficult areas. Then, in Table 9, the shift has been of more teachers having gained familiarity with the areas initially classified as most difficult.

Table 8: Teacher familiarity with all syllabus areas (before)

	No	Yes
Frequency	9	18
Percentages	31.0	62.1

In order to determine statistically if the change in observed frequencies depended on the 'before' and the 'after' intervention, the chi-square test is conducted. This exercise is to statistically determine if the intervention was effective. The hypotheses are:

H_0 : Observed change is independent of whether it was before or after intervention

Table 9: Teacher familiarity with all syllabus areas (after)

	No	Yes
Frequency	25	3
Percentages	86.2	10.3

*One teacher could not be traced at this stage

H_a : Observed change depends on whether it was before or after intervention

The observed frequencies are sourced from Tables 8 and 9 and natively presented in the first set of Table 10, and the expected frequencies are:

Table 10: Frequencies of teachers familiar with syllabus areas before vs. after

Observed (<i>o</i>)	Yes	No	Expected (<i>e</i>)	Yes	No
Before	9	18	Before	16.7	10.3
After	25	3	After	17.3	10.7

The value of the test statistic is:

$$\chi^2 = \sum \frac{(o-e)^2}{e} = 18.2315.$$

The D.F. = $k - 1 = 2 - 1 = 1$. The critical-value at the 5 percent significance level is $\chi^2_{0.05} = 3.843$. The test statistic is larger than the critical-value. Thus, the null hypothesis is rejected. We conclude that the observed change depended on the intervention. In simple terms, there is sufficient statistical proof at the five percent significance level that the intervention improved the teachers' understanding of the concepts which they had identified as difficult.

Areas Identified as Most Difficult

Most of these teachers claimed that they had not been taught the areas in calculus, financial maths, statistics and (surprisingly) trigonometry when they schooled and when they trained to be teachers. Therefore, these areas were problematic for them.

DISCUSSION

In this discussion, the schools are identified as #1 for school 1, #2 for school number 2, and so on. The figures (Figs. 1a-1g) show schools #1, #3 and #5 to have improved in matric maths performance while schools #2, #4, #6 and #7 did not improve. However, careful check shows that schools that did not improve entered the remedial exercise with pass rates exceeding fifty percent, whilst the others had passes below fifty percent. Thus, the interventions were suitable for schools with less than fifty percent pass rates. This finding shows that an intervention may apply in one setting and not in another (Henri et al. 2017). According to Krishna et al.

(2017), only holistic and robust methods ensure full coverage and foolproof.

Behaviour during the Execution of the Program

SMU lecturers taught the school teachers the difficult maths areas, and in some cases the learners were also taught. The lecturers mostly wanted to focus their teaching to the areas that were fundamental at tertiary level. As a result, where the teachers were involved, they tried to teach every area in the syllabus because SMU lecturers were assumed to be watching. The maths learners who were interviewed indicated that visitations by SMU academics to their schools inspired them to study hard. Another indication was that the learners participated more than habitual to impress the SMU lecturers, even in instances where their teachers were teaching. Apparently, the presence of SMU academics was principally persuasive on learner participation during lessons. It is common, according to France et al. (2012), that guests' presence tend to inspire extraordinary performance of internal contributors.

Social Responsibility

Social responsibility was demonstrated when the SMU academics intervened to improve the matric maths teaching in schools. Its impact was beneficial (Adler 2017) since the matric maths results were improved. If these initiatives were to elongate, or be sustained, then the local communities to SMU would in the long-term progress and improve. The maths teaching intervention qualifies as social responsibility due to its moral intent of upgrading teaching of an important school subject (Brusilovskiy et al. 2016).

Dialogue

The school teachers and SMU lecturers communicated by entering dialogues because there were genuine concerns of low matric maths performance that caused student failure and drop out at tertiary level. SMU lecturers were bothered by students' maths quality after enrolling, which was identified as having originated from school. The maths teachers also recognized and acknowledged their teaching limitations. These

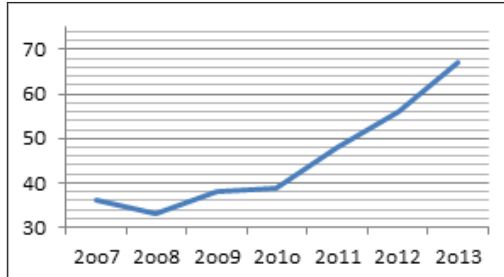
Trends on Results of Seven Participating Schools

Fig. 1(a). Trend for school 1

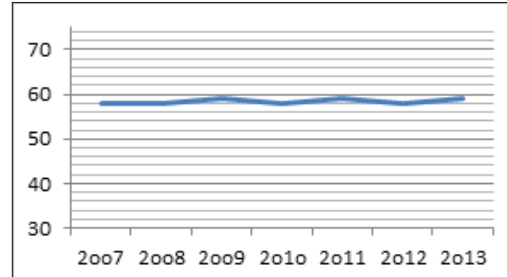


Fig. 1(b). Trend for school 2

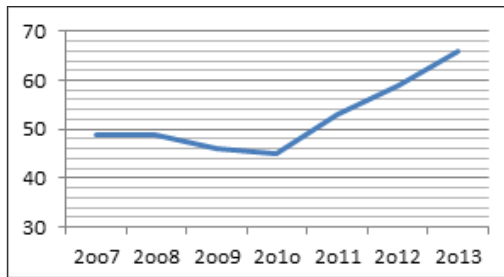


Fig. 1(c). Trend for school 3

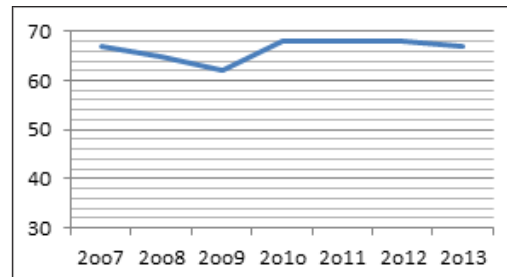


Fig. 1(d). Trend for school 4

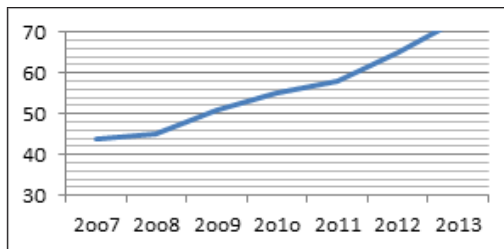


Fig. 1(e). Trend for school 5

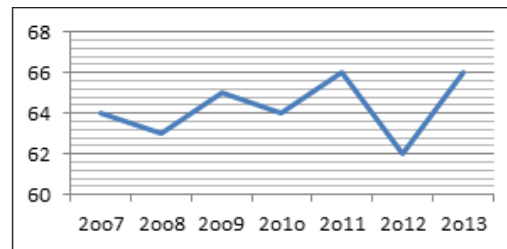


Fig. 1(f). Trend for school 6

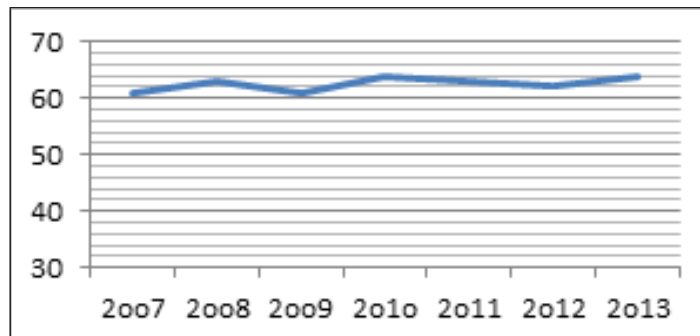


Fig. 1(g). Trend for school 7

two parties then shared their concerns using dialogues. These dialogues led to notable improvements in teaching maths. They brought parties together, inspired understanding of each other's strengths and limitations, showed where each could contribute and what they stood to gain (Adler and Venkat 2014; Adler and Ronda 2017).

Relations

The established relationships enabled academics to extend their roles of professional care and student support (Verduyn et al. 2017). The ultimate outcome was that school teachers, learners and communities local to a university campus benefitted.

Accountability

The SMU researchers and academics committed to the maths teaching intervention as if they benefited at personal level. The study revealed that they did not benefit anything at individual level. However, they accounted for every task that they had promised. This was a display of commitment and social responsibility (Hoover et al. 2016).

Sustainability

Beneficial initiatives can be sustained if supported, and they should be supported. Funding the intervention was easy because the costs were low. There was no long-distance travel. However, for extending the intervention to other schools, some funding may be needed. Also, other academics coming from far universities may have to be recruited. If this happens, more funding could be needed because other role players may have to travel long distances. This envisaged development has potential to threaten the sustainability of future intervention programs (Morelli 2011).

Action Research

The intervention program was implemented as a result of action learning that the SMU lecturers undertook. These academics had to understand what they needed to do to help. They saw a gap, and learned how they could close it (Anderson 2017). The gap consisted of poor matric maths performance and deficient maths capability learning beyond matric. Then the SMU

lecturers used their superior maths knowledge to intervene (Rowell 2017).

CONCLUSION

The methodology where action research was involved showed to be vital. It enlightened the teacher-lecturer team to understand their strengths and limitations for addressing the study problem and to administer the solution. Social responsibility was also confirmed. The local schools, and therefore the community, benefited from the exercise. Teachers' skills in maths teaching improved and learner pass rates increased. Statistical tests also showed that increased skills came from the program. Collaborations were necessary between teachers and academics, especially for the teachers who did not study through university education. Statistical tests indicated that the academics' initiative to empower school maths educators was beneficial. SMU lecturers' involvement in teaching maths in schools ensured that these teachers knew the learners' needs to study the sciences at university. The lecturers could then help to enable maths teachers to prepare the learners effectively for tertiary studies. The intervention program was beneficial more especially for low performing schools.

RECOMMENDATIONS

The study recommends that:

- ♦ Remedial programs should be
 - o Provided to more secondary schools; and
 - o Enriched for schools with over fifty percent pass rates.
- ♦ Lecturer-teacher discourses should be sustained on various issues, such as curriculum and syllabus changes at school and tertiary levels.

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