INVESTIGATION AND ALLEVIATION CONCERNING THE REASONS FOR POOR PERFORMANCE IN INTRODUCTORY MATHEMATICS AT TECHNIKON NORTHERN GAUTENG (SA)

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1 INTRODUCTION AND BACKGROUND

The failure rate in mathematics at school is high. Internationally research studies have reported underachievement in mathematics (Blankley, 1994; Nongxa, 1996; Gerardi, 1990). In South Africa it is reported that only 23% of grade 12 learners passed their mathematics matriculation examination between 1990 and 1995 (Anstey, 1997: 8). There is a vast gap between the achievement by and the quality of schooling provided for African students and schooling provided for white students (Blankley, 1994: 54). Blankley (1994: 54) indicated that one in 312 African students who entered school in 1980 qualified for university in both mathematics and physical science. The equivalent statistic for white students is 1 in 5.1. Technikon Northern Gauteng (TNG) is a historically disadvantaged institution and the majority of the students are from historically disadvantaged backgrounds. One of the consequences of this sustained disadvantage is that students are often under-prepared for tertiary education. Another disadvantage is that students often lack basic resources, such as textbooks and calculators, for academic progress (Turner, 2000: 16). Most of the students in introductory mathematics (MTHS1) could be described as “at risk”

> *The term “at risk” is used as an euphemism for students who were exposed to a wide range of educational factors, including the manifestation of unacceptable social behavior, the inability to keep up with the pace of instruction, the failure to respond positively to the instruction offered in basic academic skills, and a limited repertoire of experiences that provide background for formal education* (Howard & Anderson, 1978: 221-231).

Students often underachieve in mathematics as a result of poor teaching. Freudenthal (1980) cited by Maree (1996: 7) stated that mathematics is more vulnerable to poor teaching than any other subject. The failure rate of students in MTHS1 has been a concern at TNG for some time now, but during semester one of 1999 it reached an all time low. The pass rate was 32,73% whilst 35,45% of students were refused from writing the examinations since they did not acquire a year mark of at least 40% for mathematics.

2 ACTION TAKEN BY THE DEPARTMENT OF PHYSICAL SCIENCES

Mathematics is offered by the Department of Physical Sciences and is a service subject to all the departments in the Faculty of Engineering. The students are admitted and registered by those departments according to their admission criteria. There are usually about 700 students in MTHS1 during the first and 350 during the second semester.

The lecturers involved in the teaching of MTHS1 decided in 1999 to use action research in order to act on alleviating some off the identified reasons for the poor performance. The reasons discussed here were intuitively identified through observation and literature review and are by now means comprehensive.

2.1 REASONS FOR UNDERACHIEVEMENT

2.1.1 Insufficient pre-knowledge

At the Meeting of Experts on the Goals of Mathematics Education held in 1980 the weakness in teacher education was singled out as the biggest obstacle to progress in mathematics in most countries of the world (Vithal, 1992: 2). The commonwealth Expert Group reported (Vithal, 1992: 2) that in South Africa there are teacher shortages of between 70 and 90 percent in mathematics and science within African schools. It is not merely a shortage in numbers, but also in quality (Smith & Schalekamp, 1997: 23). This has an adverse effect on the pre-knowledge of students entering tertiary education.

2.1.2 Medium of instruction

The Language of instruction is English and that is not a first language to the students at TNG. Research has shown that language minority students often under-achieve. Students with a second language disadvantage together with a low socio-economic position and discrimination on grounds of race were found not to perform as expected (Rosenthal, Baker and Ginsburg, 1983: 157-169).

2.1.3 Large class groups

The number of students per group has increased from 24 per group in 1984 to between 50 and 70 at the moment. This is partly due to an attempt to secure more funding by putting more students through the system (South African National Educational Policy, 1989). There is much diversity in such a group, since the students could be from nine different culture groups, speaking any of the nine African languages. It became impossible for the lecturer to get to know the students since they only have lectures three times a week. Students could easily become isolated and lonely with nowhere to go with their problems. They easily fall behind, as they are not used to the tempo of work at tertiary level and are unfamiliar with a culture of learning and teaching (Lethoko, Heystek & Maree: 311).

2.1.4 Admission criteria

Venter (1998) indicated that the result from the matriculation examinations predict very accurately the student's ability to succeed in a bridging course that was active at that time at TNG. The bridging course served as a six months preparatory course for MTHS1 and revised all the important and relevant mathematics from the school syllabi. Venter (1998) reported a correlation of 0,97 between the entrance score and the final result in the bridging course. The study indicated that the entrance score was a good predictor of their subsequent success in their study of mathematics. The study concluded that a Standard grade C-symbol in grade 12 mathematics should be the cut-off point for admission to tertiary education in engineering. Yet this study had no effect on students enrolment, potentially to economic imperatives.

2.1.4 Study habits

During observations done by the lecturers in mathematics at TNG it was found that the majority of students in MTHS1 at TNG only work on their mathematics during the contact periods and are often absent from lectures. Only a few students complete the homework and have organized notes and notebooks. Assignments result in mass copying of a few original attempts. For example on one occasion there were only 43 out of 62 students present in the lecture. There were only three textbooks and 13 sets of information tables amongst them. These are tables that we use on a daily base and were supplied to every student. Only twelve students attempted the homework, but did not fully complete it and only one student completed all the homework. The homework consisted of four problems on implicit differentiation.

2.2 THE ACTION RESEARCH (AR) PROJECT

2.2.1 Definitions of action research (AR)

According to Cohen and Manion (1980: 178) AR is "*essentially an on-the-spot procedure designed to deal with a concrete problem located in an immediate situation. This means that the step-by-step process is constantly monitored over varying periods of time and by a variety of mechanisms (questionnaires, diaries, interviews and case studies, for example) so that the ensuing feedback may be translated into modifications, adjustments, directional changes, redefinitions, as necessary, so as to bring about lasting benefit to the ongoing process itself.*"

From an educational perspective Zuber-Skerritt (1992a:1-2) defined AR as

a collaborative, critical inquiry by the academics themselves (rather than expert educational researchers) into their own teaching practice, into problems of students' learning and into curriculum problems.

Zuber-Skerritt (1992a & 1992b) is convinced that AR can improve educational practices as well as empowering the participants of these research projects. The model by which Zuber-Skerritt (1995: 13) now describes AR has already been through a few changes since the beginning of AR (Figure 1).

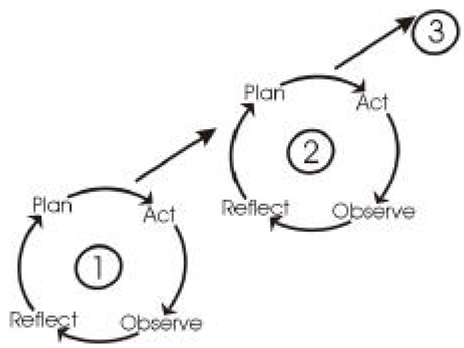

Figure 1

2.2.2 Implementation of the project

The aim of this AR project at TNG was to allow and encourage students to solve mathematical problems and to practise mathematical skills in a small group setting through the help of the tutor. The four moments of AR as mentioned by Kemmis and McTaggart (1988: 11) are:

❖ Plan

The author received intensive training from Prof. Ortrun Zuber-Skerritt and Prof. Sandra Speedy as part of the Australian Links Programme. The author got an AR set consisting of interested mathematics lecturers. The set members agreed that the area where lecturers could best intervene would probably be in the field of 'study habits'.

❖ Act

It was decided that the students should be placed in tutorial groups and were to receive tutorial classes on a weekly base from trained tutors. The tutors were senior students who were trained by the set members. The tutors had weekly meetings in order to have constant communication with the rest of the set. The tutors were issued with tutorial exercises for the weekly sessions and they also had to conduct a small control test every week. These marks contributed towards the semester mark of the students.

❖ Observe

To observe means to document the outcomes of critically informed action. Observation should not be limited to categories as it turned out to be too narrow, be ready to expect the unexpected. The set members and the tutors gathered data through a variety of methods.

- Observations
  The lecturers as well as the tutors made structured and unstructured observations.
- Reflection diaries
  Are important tools to keep track of specific incidents and actions taken, together with the outcome thereof. It is crucially important to keep record of everything that went wrong. This should be shared in the set meetings, since that would give direction for adjustments and modifications for the next cycle.
- Questionnaires
  This is still a very powerful tool for data collection and provided qualitative and quantitative data. The design is important and time should be taken to ensure a proper questionnaire.
- Focus group interviews
  Similarities and tendencies were picked up through the questionnaires and were followed up by focus group interviews. This ensured information rich data as well as triangulation of data.
- In depth interviews
  In this project we invited students to volunteer for in depth interviews if they felt that they had something specific to contribute towards the project outcome.
- Documents and artifacts
  All correspondence between students, tutors and lecturers including the control tests and mark sheets have potentially useful data.

❖ Reflect

To reflect is to recall the action that was recorded in observation, but it is also active. Reflection goes hand in hand with discussion amongst set members. Through discussion the group gets to a point where they can formulate a revised plan based on reconstruction of events that have taken place. Reflection has an evaluation side to it as set members have to judge if their outcomes were successful and the effects desirable. The members have to suggest remedial actions if necessary. The knowledge from the reflections shaped the project itself. Actions that were taken reorganized the beliefs about how the project should be conducted.

The project was administered during the second semester of 2000 and the first semester of 2001. The data was analyzed throughout the project and strategies were implemented to enhance validity and reliability.

2.3 RESULTS

The project seemed to have achieved a lot more than it set out to do.

- The pass rate

The pass rate increased from 32,73% and 41,30% for the two semesters of 1999 to 54,74% and 50% for the semesters during which the project was active. The rate, at which students were refused to write examinations, dropped from 35,45% and 33,33% (1999) to 24,74% and 26,7%.

- The students

The students found the project to be very supportive and many realized the long-term benefit of establishing a network for assistance in the practicing of their mathematics problems. The fact that in some instances they could use their mother tongue during tutorials, was an added bonus and the tutors became positive role models.

- The lecturers

The project empowered the lecturers through the improvement of their practice as well as enriched them personally. The members learned about synergy, i.e. that the outcomes are more than the sum of the parts and also learned to share information, positive and negative. The project invigorated the team spirit in the department.

Action research has not yet been fully accepted in all academic circles (Adler, 1992: 150), but has made good progress in recent years. The members of this AR group hope to contribute in a small way in motivating teachers to become involved in this kind of grassroots research, since it does not only improve your practice, but also enrich you personally.

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