Running a Mathematics Resources Unit: Some Reflections[1]

Sundari Muralidhar

Introduction

The University of the South Pacific (USP) is into its 25th year. The USP serves twelve countries in the South Pacific region through its main campuses in Fiji and Western Samoa and through its Extension Centres in eleven of the twelve member countries.

The University runs its programmes through the School of Humanities (SOH), the School of Pure and Applied Sciences (SPAS), the School of Social and Economic Development (SSED) situated on the Laucala Campus in Suva (Fiji) and School of Agriculture (SOA) on the Alafua Campus in Apia (Western Samoa). The Distance Education programmes are run through University Extension. Materials for the courses under these programmes are all produced with the help of the academic staff of the four schools. There are six institutes which look after consultancy, research and the running of short courses according to the needs in the region.

Academic Support Units

The Computer Centre and the Media Centre offer the much needed academic and technical support to staff. The Centre for the Enhancement of Learning and Teaching (CELT) is the newest centre, and was established to support students and academic staff. The Centre assists academic staff to conduct research into their own teaching by providing the relevant information through special workshops and seminars. The other important service which CELT offers is supporting students towards their studies in mathematics and English. The Mathematics Resource Unit (MRU) and the English Resource Unit (ERU) provide these services. Until the beginning of 1992, the MRU was a part of the Department of Mathematics and Computing Science in

[1] Based on a paper presented at the Australian Bridging Mathematics Network conference, University of Queensland, Brisbane, 6-8 July, 1993.

SPAS, while the ERU was a part of the Literature and Language Department in SOH. In 1992, these two units were made a part of CELT, as it was felt that the units could function better as a separate centre.

Student Population

The USP has students coming from diverse cultures. The majority of our students come from Fiji, where the population consists mainly of Indo-Fijians and ethnic Fijians with some Chinese and other Pacific Islanders. The remainder of our student population comes from the Cook Islands, Kiribati, Marshall Islands, Nauru, Niue, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Western Samoa. This cultural diversity offers a unique challenge to both our students and staff in fulfilling our obligations.

Functions of the MRU

The functions performed by the MRU are very similar to Mathematics Support Centres elsewhere. But the challenges faced in performing these functions successfully are quite unique at the USP as highlighted in the above section.

The main users of the MRU are Foundation and first year degree mathematics students. The Department of Mathematics and Computing Science offers two mathematics courses (MAF11, MAF21) at the Foundation level and two courses (MA111, MA101) at the first year degree level during the first semester. The MAF11 course satisfies the requirement of the Foundation Science programme, while MAF21, the requirement of the Foundation Social Science programme. At the first year degree level, MA111 is required for majoring in mathematics, computing science or physics, while MA101 is run as a service course for students intending to major in the social sciences, biology or chemistry. Foundation Mathematics students are usually those who have passed Fiji School Leaving Certificate (FSLC) or the Pacific Senior Secondary School Certificate (PSSC) examination the year before. MA111 and MA101 students are generally a mixture of mature age students and those who would have done Form 7 in schools or Foundation at the USP.

Students doing some statistical components within their social science units,

also visit the MRU seeking advice and guidance on the use of appropriate materials. Running special sessions for students at lecturers' requests is another function of the MRU.

The MRU also assists the Institute of Education to run in-service training courses in mathematics for secondary teachers in the USP region.

Students use the MRU as a drop-in Centre to seek immediate assistance with their studies or to obtain assistance to improve their mathematical abilities over a period of time, as suggested by the MRU co-ordinator. It is during the consultation period that the co-ordinator is able to guide students to the variety of materials available in the MRU. Students are also referred to the MRU by lecturers and tutors.

History of the Foundation Programme

Until the end of 1991 those students in Fiji who were sponsored by the Ministry of Education did the Foundation Programme at the USP. The other qualifying students did Form 7 in the few schools where it was available. Similarly, students from other countries in the region were also sponsored by their governments for Foundation studies at the USP. Minimum qualifications for entry to the Foundation or Form 7 programme used to be a pass in New Zealand University Entrance (NZUE) Examination as almost all countries in the USP region took this examination until 1989. In 1989, Fiji started running its own FSLC programme while Kiribati, Tonga, Solomon Islands and Western Samoa started the PSSC Programme. Vanuatu joined these countries in 1993.

The USP ran the Foundation Science and Social Science programmes until the end of 1991, at the request of the regional governments. In 1992, the Fiji government decided to expand its Foundation programme as Form 7 in some selected secondary schools. The idea was to relieve the University from this commitment to allow it to concentrate on other pressing needs in the region. But the University continued to run the Foundation Programme at the request of the other regional governments. This was for a small number of students who had gone through the PSSC programme or an equivalent examination, in their senior high school.

connections as well as the separate rules" (Skemp, 1976:23). This results in a larger amount of learning 'to do'. But Skemp argues that it is worth teaching with this emphasis, as the result, once learnt, is more lasting. This way, there is less re-learning 'to do'. The difficulty often experienced by many primary, secondary and tertiary mathematics teachers that "students forget mathematical ideas too fast" could perhaps be overcome by teaching for relational rather than instrumental understanding.

Students who have been taught with an emphasis on instrumental understanding cannot be tested for relational understanding. Similarly, one cannot "appropriately test understanding of a concept by having the learner state facts or perform a skill." (Ehrenberg, 1981:42).

The above considerations had an important bearing on the construction of the diagnostic test.

The Diagnostic Test

The diagnostic test was constructed by framing questions based on five algebraic skills:

- expanding binomials
- factorising binomials and trinomials
- simplifying rational, surdic, exponential and logarithmic expressions
- solving quadratic, exponential, simultaneous, logarithmic and trigonometric equations and linear inequations
- solving word problems involving the construction of linear, quadratic and simultaneous equations.

The term "diagnostic test" was deliberately avoided on the paper so that it did not put students off. Students were told that they were going to answer some questions to allow them to review the concepts and skills learnt in their secondary mathematics. They were also told that some of them would be directed to do further work based on their responses to the questions.

also visit the MRU seeking advice and guidance on the use of appropriate materials. Running special sessions for students at lecturers' requests is another function of the MRU.

The MRU also assists the Institute of Education to run in-service training courses in mathematics for secondary teachers in the USP region.

Students use the MRU as a drop-in Centre to seek immediate assistance with their studies or to obtain assistance to improve their mathematical abilities over a period of time, as suggested by the MRU co-ordinator. It is during the consultation period that the co-ordinator is able to guide students to the variety of materials available in the MRU. Students are also referred to the MRU by lecturers and tutors.

History of the Foundation Programme

Until the end of 1991 those students in Fiji who were sponsored by the Ministry of Education did the Foundation Programme at the USP. The other qualifying students did Form 7 in the few schools where it was available. Similarly, students from other countries in the region were also sponsored by their governments for Foundation studies at the USP. Minimum qualifications for entry to the Foundation or Form 7 programme used to be a pass in New Zealand University Entrance (NZUE) Examination as almost all countries in the USP region took this examination until 1989. In 1989, Fiji started running its own FSLC programme while Kiribati, Tonga, Solomon Islands and Western Samoa started the PSSC Programme. Vanuatu joined these countries in 1993.

The USP ran the Foundation Science and Social Science programmes until the end of 1991, at the request of the regional governments. In 1992, the Fiji government decided to expand its Foundation programme as Form 7 in some selected secondary schools. The idea was to relieve the University from this commitment to allow it to concentrate on other pressing needs in the region. But the University continued to run the Foundation Programme at the request of the other regional governments. This was for a small number of students who had gone through the PSSC programme or an equivalent examination, in their senior high school.

In 1993, however, a number of students from Fiji were permitted to enrol in the Foundation Science programme at the USP. All these students had passed the FSLC Examination. This meant that the Foundation Mathematics course was going to be offered to a mixture of two groups of students who had gone through two different programmes both in their junior and senior secondary years.

Need for Diagnosis and Remediation

It was against this background, as the co-ordinator of the MRU, that I felt it necessary to discuss the possibility of assisting Foundation Mathematics students in 1993. The discussion I held with the Foundation Mathematics co-ordinator in December 1992 resulted in the following steps being taken :

1. The construction of a test which could diagnose the extent to which Foundation entrants were ready to cope with their mathematics studies.

2. The request by the Foundation Mathematics co-ordinator for other tutors to administer the test and assist in its marking.

3. The running of some special sessions for the Foundation students who were selected on the basis of their performance in the test.

In constructing the diagnostic test, the following documents were consulted:

1. The aims, objectives and content of the algebra section of the FSLC and the PSSC Mathematics Prescriptions.

2. The content of the Foundation Mathematics course.

3. The 1991 FSLC and PSSC Mathematics Examiners' Reports.

The Foundation Mathematics co-ordinator was consulted regarding students' performance on the algebra section of the mathematics examination in the previous years. A brief review was made of the literature relating to the understanding of mathematical ideas. The aims and objectives of both the FSLC and PSSC prescriptions emphasise the understanding of ideas. The

reports of the chief examiners of both the courses indicated that students lacked an understanding of some basic algebraic skills. The discussion held with the Foundation Mathematics co-ordinator also reinforced the FSLC and the PSSC chief examiners' comments.

Understanding of Mathematical Ideas

There are several possible reasons for students' difficulties in mastering algebraic skills. One reason could be that students have not understood the underlying basic algebraic concepts because of insufficient exposure to the special characteristics through examples and non-examples of a concept. It is possible that they were mainly exposed to the learning of *facts* but not to the understanding of *concepts*. This could be due to the wrong assumption that concepts are learnt in much the same way as facts are learnt (Ehrenberg, 1981). This assumption seems to have led many teachers in the South Pacific region to concentrate more on the teaching of facts than of concepts.

Pressure is also exerted on the teachers by school principals and parents to place too much importance on examinations. Thus both teachers and students are busy preparing for examinations right from the beginning of the year. Teachers are also very "cautious" of using or learning any new techniques to aid the understanding of mathematical ideas. Teachers do not want to "waste" their time in trying new methods (Muralidhar, 1989). It requires a good deal of organisation on the part of a teacher to try out any innovative ideas, as the classes usually have 40 to 50 students. Teachers often argue that if pupils are taught the skills necessary to get the "right answers", then their examination results will be good. This, perhaps, forces teachers (in Fiji and elsewhere in the region) to teach for "instrumental understanding" rather than for "relational understanding".

Richard Skemp (1976) refers to instrumental understanding as "learning rules without reasons" and relational understanding as "knowing both what to do and why". He also observes that teaching for instrumental understanding is quite widespread. He warns that if one wants to teach for this type of understanding, it "necessitates memorising which problem a method works for, and which not, and also learning a different method for each new class of problems". Acquiring relational understanding involves learning "the

connections as well as the separate rules" (Skemp, 1976:23). This results in a larger amount of learning 'to do'. But Skemp argues that it is worth teaching with this emphasis, as the result, once learnt, is more lasting. This way, there is less re-learning 'to do'. The difficulty often experienced by many primary, secondary and tertiary mathematics teachers that "students forget mathematical ideas too fast" could perhaps be overcome by teaching for relational rather than instrumental understanding.

Students who have been taught with an emphasis on instrumental understanding cannot be tested for relational understanding. Similarly, one cannot "appropriately test understanding of a concept by having the learner state facts or perform a skill." (Ehrenberg, 1981:42).

The above considerations had an important bearing on the construction of the diagnostic test.

The Diagnostic Test

The diagnostic test was constructed by framing questions based on five algebraic skills:

- expanding binomials
- factorising binomials and trinomials
- simplifying rational, surdic, exponential and logarithmic expressions
- solving quadratic, exponential, simultaneous, logarithmic and trigonometric equations and linear inequations
- solving word problems involving the construction of linear, quadratic and simultaneous equations.

The term "diagnostic test" was deliberately avoided on the paper so that it did not put students off. Students were told that they were going to answer some questions to allow them to review the concepts and skills learnt in their secondary mathematics. They were also told that some of them would be directed to do further work based on their responses to the questions.

Administration of the Test

The test was administered during one of the tutorial sessions in the second week of the semester, and marking was completed by the beginning of the fourth week. Students who had an overall score of less than 50% were directed to the MRU to attend special sessions. A total of 55 students out of 116 were directed to the MRU and were given a referral form containing details regarding the area in which he/she had to do further work in order to be ready to cope with the current Foundation Mathematics course.

Discussion of the Sessions

The sessions began in the fourth week of the semester. Students were given the programme for the first half of the semester together with the aims and objectives of these special sessions. Each group was to attend two sessions in the MRU every week on top of their other lecture/tutorial/laboratory commitments. The specially selected students were therefore told that attending the sessions was not compulsory but the advice was that it would help them to do better in their Foundation Mathematics. Students were told that the algebraic processes of expansion, factorisation and simplification would be covered in the first half and the other two processes during the second half of the semester.

Each session consisted of three principal activities :

1. initiating class discussion using the work sheets specially prepared for the purpose. This gave an opportunity to review the vocabulary involved as well as the procedure followed in these skills.

2. participating in a "card quiz" session which gave an opportunity to interact with fellow students while reviewing some basic mathematical concepts and skills.

3. using the computer packages "Weissmann's Algebra Tutorials" and "Math Blaster Mystery" which allowed students to test, practise or relearn these skills at their own pace. The computer sessions also resulted in more student interaction as students worked in pairs.

The format of the sessions was kept the same for weeks 4, 5 and 6, but changed especially for week 7. During week 7, attempts were made to expose students to the importance of learning to reflect on the ideas understood and the utility of such an action. This was done by :

1. Discussing how the skills reviewed in MRU sessions were connected to some current Foundation Mathematics topics such as partial fractions, sigma notation, binomial expansion and mathematical induction.

2. Asking students some questions which led them to construct a summary of the ideas learnt in the MRU sessions.

3. Asking students to fill in a feedback form to convey their impressions of the eight MRU sessions which they had attended.

Attendance

Attendance at these sessions varied from one group to another. It seemed to depend on the topic and the type of activity offered during the sessions. There was a tendency among some students that once they received the work sheets, participated in a card quiz session or worked with the computers, they did not come back for a second session during the week. A few students said that they would only attend if the current Foundation topics were discussed at the MRU sessions. Others expressed the view that they knew that attending the sessions was useful, but their enormous workload would not allow them to attend except when they had to prepare for a test the next day. They did, however, inform me whenever they could not attend a session.

Discussion of Responses on Students' Feedback Sheets

Students' feedback was obtained during the last session in Week 7. Responses could be collected from only 22 students, as the attendance had reduced as outlined earlier.

The feedback sheet contained a few details to be filled in by students to allow them to reflect on the work they were supposed to have completed.

The following instructions were given at the end of the feedback sheet :

Please write down your impressions on how the MRU sessions went. Also say how the sessions could be improved for the next half of the semester.

Talking to students informally, revealed that most of the students really liked using computers in MRU sessions. However, only five students made this view explicit in writing. Some of the responses supporting this view were as follows:

"more computer work"

"working on the computers has made maths seem like a more fun subject"

"...the computer software gave us the opportunity to visualise what is actually involved in factorisation, simplification and other operations"

Some of those who expressed satisfaction at the way MRU sessions went, said that attending these sessions helped them improve their understanding of mathematical ideas. One of the responses indicated the student's realisation that understanding mathematics is better than memorising. Some of the responses which indicated this view, were as follows:

"From my point of view, MRU is a tremendous session to be in with. It really helps me a lot in the understanding and my improvement in maths"

"Made me realise and understand more about Maths problems. Understanding was much better in knowing maths rather than memorising. I cannot say how it will be improved because I personally think it is already improved at the beginning. It's only me left to take in the information."

Some other responses contained suggestions that students should be provided with a summary of all the important points taught, a test should be set to let the students know how much they had learnt, their exercises should be marked, or more card-quizzes should be provided in the second half of the semester.

Some of the responses that gave these indications were:

"....I would like to suggest a summary sheet of all the weeks work to be given out during the last session of the week. This would help us write all we should have learnt throughout that week"

"MRU sessions are quite helpful in improving some of the areas in maths which I am weak in. The sessions could be improved by having a short test after every topic so that we can know if our learning is in success or not."

"I like the way MRU session is organised for the past few weeks. I hope that it will continue on for the next half of semester 1. Suggestn--- I would suggest if more card quiz is provided for us during the session."

"...It would improve if our work sheet should be marked by the coordinator after each session so we could realize our mistakes."

One student, however, expressed dissatisfaction that the current Foundation Mathematics topics were not discussed during the MRU sessions but on second thoughts seemed to realise the purpose of the MRU sessions. This student's response was :

"With the small no. I reckon these sessions are going fine. I guess it could be improved if we were dealing with the current topics but then that's what the tutors are for!"

I believe that these responses provide valuable information on what students' expectations are. I was able to act on some of their suggestions in the latter half of the semester. However, I could not do it to my satisfaction owing to the constraint that I am the only staff member looking after the functions of the MRU. This limits the time that can be devoted to students and to pursuing research studies that can feed into the work of the MRU.

Reflections

Reflecting on my experience of MRU sessions with students, I would like to

offer the following suggestions for enhancing the learning and teaching of mathematics.

Lecturers should try using alternative techniques and strategies in tutorial sessions, similar to the ones used in MRU sessions. There are benefits to be gained both by tutors and students.

It is also useful to ascertain students' views on how tutorial sessions should be run. This will help us in making the tutorial sessions more effective and productive from a student's point of view.

Students need to be exposed more often to the technique of making summaries and linking the ideas learned. Students' ideas can be probed using techniques such as concept mapping either in lecture/tutorial sessions or in the MRU sessions. There is also a case for running a short bridging course in mathematics with emphasis on teaching for understanding of concepts to promote relational understanding.

In our attempts to encourage confidence in students, an effective professional link between the Department of Mathematics and Computing Science and the MRU in CELT is vital. This cannot be achieved by the MRU co-ordinator alone - a genuine co-operative spirit must be generated between the two sections so that our students can be helped to overcome the fear of mathematics and begin enjoying the subject.

Conclusion

In this paper, I have attempted to share some of my experiences in helping students to gain confidence in doing mathematics. It has been an enjoyable experience, though challenging at times, as it has allowed me to observe how students from different cultures approach learning mathematics and their attitudes towards using computers in learning the subject. This has helped me realise the importance of adding a human touch to the learning of mathematics by getting them to talk and write about it along with doing it. This, in turn, might help students acquire a better understanding of and therefore a better attitude towards the subject.

References

Ehrenberg, S.D. (1981). 'Concept learning : How to make it happen in the classroom. *Educational Leadership,* 39 (1), 36-43.

Muralidhar, S. (1989). *Students' Understanding of Number Operations and Fractions at the Junior Secondary Level in Fiji.* Unpublished M.Ed Studies Project, Monash University, Melbourne.

Skemp, R.R. (1976). Relational Understanding and Instrumental Understanding. *Mathematics Teaching,* (77), 20-26.