Fiji Secondary Mathematics : Looking Ahead

Babu Prasad

Introduction

In the following article the writer makes three main proposals which he believes will lead to improvements in the teaching and learning of mathematics. They are as follows:

(a) *A better integration of the curricula is needed; it needs to be reflected in better locally-produced textbooks with a strong focus on* ***algebra and co-ordinate geometry.***

(b) *An* ***alternative*** *to the present single-track curriculum is needed; the net effect of a dual-track curriculum would be a reduction of the problems and difficulties presently associated with secondary mathematics education in Fiji.*

(c) *Some* ***large-scale empirical studies*** *need to be undertaken. Appropriate models borrowed from abroad could be used. Special* ***research-based efforts*** *to increase the achievement of Fijian students especially appear urgent.*

Fiji has now localized the syllabi and the examinations in mathematics. For several years the Overseas School Certificate and the General School Certificate Examinations from the United Kingdom ruled life in the mathematics classroom. Then in the 1960's came the switch to the New Zealand syllabi and examinations - the School Certificate and the University Entrance Examinations. In fact, for the last 15 years 'UE' was a household phrase. Recently the former was dropped and the latter replaced by a local examination - the Fiji School Leaving Certificate (FSLC) Examination, which was first offered in 1989. Now the educators in Fiji have the freedom to develop the curricula, syllabi and examinations to suit the needs of the children in this country.

Below are some suggested directions for the future development of secondary mathematics in the country. The discussion here is deliberately broad since the specifics would need to be worked out by the various authorities involved. These suggestions, if followed, could do much to help all students in Fiji to make advances in their mathematical skills.

Integration

With the rise of the junior secondary schools in Fiji in the 1970's, the syllabi, curricula and examinations for Forms 1-4 leading to the Fiji Junior Certificate Examination were developed. Attempts were made by the United Nations Development Program staff based at the University of the South Pacific in Suva in the early 1970's to develop a curriculum that was integrated. The Form 1-4 mathematics program appears well integrated, although there is an urgent need to revise it.

Attempts have been made recently to integrate the Forms 5 and 6 syllabi (Fiji School Leaving Certificate Examination Prescription, 1989). The dropping of a Form 5 external examination and the localization of a Form 6 external examination provided this opportunity, and it appears quite successful.

However, there is a need now to examine the secondary mathematics picture as a whole (i.e. Forms 1-7). This is particularly important in view of the phasing out of the USP Foundation Programme. Against this background, there will have to be more Form 7 courses offered at school as Form 7 is likely to become the recruiting level for employers, who will ask for 'a pass in English and mathematics in the Form 7 examination'. In fact, this trend has already begun and is gathering momentum.

In examining the entire secondary mathematics program, one would need to attend to the placement of the topics at various levels. For example, trigonometry and logarithms could be transferred from Form 4 to the senior forms; plane geometry topics could be reduced and taught at the

Form 4 level; Form 6 work could also incorporate the general circle, $(x-a)^2 + (y-b)^2 = r^2$; transformation geometry, a considerable burden in Form 3, could be trimmed considerably and room made for more algebra. The role of matrix and matrix transformations could be re-examined. In fact, the topic of matrix was omitted from Form 4 work recently. These two topics could be moved to Form 7 level or dropped altogether from high school work. Should the junior forms study set theory? Is the topic as central as it was thought by some in the 1970's? Should constructions be taught at all? For example, do our students need to know how to bisect a line with a pair of compasses? In the age of calculators, the students do *not* need to know how to simplify surds without using calculators; e.g.$4\sqrt{2}$. What is wrong with simplifying such an expression using a calculator? Should the students need to know how to use logarithms to multiply and divide numbers as they had to before the advent of the scientific calculators?

Algebra

Algebra is studied in all forms in Fiji. However, it is a difficult area for many students (including those in other countries). Therefore, there is a need to lay greater stress on algebra in every form.

Examiners' reports on the New Zealand School Certificate examination in mathematics, for example, point **repeatedly** to the students' weaknesses in algebra. The Chief Examiner's Report in 1986 stated categorically that"Knowledge of algebra was weak" (p.1). For example, a large percentage of students (including Fiji students) who sat that examination could not make the subject of the formula in $p = q/r$. This moved the Chief Examiner to comment:

> *This part of the prescription appears to be little understood (Chief Examiner's Report, New Zealand School Certificate, 1986, p.5).*

A similar weakness was found the following year. For example, 99% of those who sat the South Pacific Option Paper could not factorize $1-x^2$.

Findings such as those above led the Chief Examiner to make the following comment:

> *On the whole, algebraic skills are in need of some intensive teaching. Form 6 mathematics demands better algebraic skills than were in evidence in this year's scripts, even in those candidates who scored well in the examination, and are most likely to proceed to Form 6 (p.4).*

The examiner went on to highlight specifically the poor levels of skills in graphs, relations, functions and co-ordinate geometry. These weaknesses, in fact, reflected a 'disturbing' finding since these topics are an important feature of Form 6 mathematics.

Those criticisms were repeated in the Examiner's Report (1990) of the FSLC Mathematics examination. For many Form 6 students, the Report said, the basic mathematical skills in arithmetic and algebraic manipulations are so weak that they would be better off repeating Form 5 work. It identified the following basic skills that many 'badly lacked' (p.1):

> *Multiplication and addition of fractions; simplification; changing the subject of the formula; use of set-builder notation; labelling/dividing axes and sketching graphs; ability to cast word problems into equations.*

The Report emphasized that *in many cases the students knew what to do but their mathematical skills and algebraic manipulations let them down* (p.2). It cited the following examples of the students' general weaknesses:

a) In solving $x(x+2)=24$, many wrote $x=24$ or $x+2=24$.

b) Many could not make m the subject of the formula in $m. m_1 = -1$

c) Many did not know the meaning of the term show.

d) Many could not sketch graphs from tables. Some sketched a cubic graph using a ruler.

Overall, the Report suggested that more emphasis be given to Form 5 material. Simultaneously, it pointed a finger at junior mathematics.

> *It is quite evident that these basic mathematical skills are not being emphasized at Form 1-4 level. (p.1)*

Students' weaknesses in Forms 1-6 mathematics appear to cripple the Form 7 students. Comments from the Mathematics Examiner's Report (1987) for Form 7 in Fiji are worth noting carefully:

> *... a general weakness in algebra was seen in the work of candidates from all the centres. This area of mathematics needs to be given a lot of emphasis and importance (p.2).*

The algebraic skills needed in Forms 6 and 7 are **not and cannot** be taught in these forms. The weaknesses need to be addressed **earlier.** The writer believes that **Forms 4 and 5** are critical levels. Perhaps delimiting the syllabus at these levels, but deepening it with respect to algebra and co-ordinate geometry may help. The use of a locally produced Form 5 text that stresses algebra and co-ordinate geometry should help to improve the students' skills in those areas. Regular reviews, remedial lessons and quizzes on junior algebra throughout the year in Form 5 may also help. Replacing the Diploma in Education teachers at Form 5 level with teachers who have a degree in mathematics and are therefore qualified to teach senior mathematics is essential. Developing separate syllabi, curricula and examinations for college prep and non-college-prep students in senior forms would strike at the very root of the problem. This last suggestion is discussed in detail later in this article.

Texts

The curriculum in Fiji is now fully localized. However, the senior mathematics classes still use New Zealand textbooks, which do not adequately cover the local curricula. Some go out of print posing great hardships for Fiji students. There is a need, therefore, to produce a set of textbooks locally for Forms 5 and 6. Once they are written, the prescription could be more carefully developed and integrated. In fact, the **scope and sequence** of teaching various topics could be defined more carefully by the topics as elaborated in the texts. These texts also need to include **Review Tests** and some copies of previous years' examination papers to reinforce the knowledge to be acquired within each topic.

Attempts should also be made to write a suitable text for Form 7 mathematics using local material. The revision of the Form 7 mathematics programme should help it considerably and can be regarded as a first step in the right direction.

It is also important to revise the junior mathematics texts that are being used nationwide. They were written in the early 1970's during the heyday of 'modern mathematics' when the **discovery** method was looked upon as the royal road to the teaching and learning of mathematics. In the late 1970's and more so in the 1980's, considerable rethinking on the role of the 'discovery method' in the technologically advanced countries such as the U.S.A., the U.K. and Australia has led to its decline (see Hill, 1976; Kline, 1973, 1976). It might be worth adding that the mathematics texts written in those countries around 1970 have been completely revised or replaced by books with an orientation that no longer favours that method.

It is essential that any text, once written and trialled in selected schools in Fiji, be thoroughly evaluated and revised before it is introduced as a text-book nationwide. This procedure would help avoid the costly mistakes several countries have made in the last two decades.

Curriculum

The Fiji mathematics curricula, syllabi and examinations at Forms 4 and 6 are aimed at **all** types of students. Considerable difficulties in planning, teaching and learning originate from this single fact. Up to Form 4, the tenth year of schooling, a general mathematics program appears acceptable to most people in any country. But beyond it, the students' goals in studying mathematics become more differentiated. Hence, there is a need to split the senior mathematics program in Fiji into two broad types to cater for these differences. This is especially so since the number of students proceeding to tertiary level is tiny compared to those gaining employment after Form 6.

The present senior mathematics program is a mixture of two types of program. It contains **largely** college-prep mathematics, with a smaller amount of mathematics that is intended for the non-college-prep students. In trying to satisfy both clienteles, it satisfies neither very well. For example, it is not very challenging to the college-prep students. At the same time many topics in it are too abstract or even irrelevant to the needs of those clearly not cut out for mathematics/science study beyond Form 6. A solution is to offer **separate** programs. The separation of the present curriculum would go a long way not only in preparing the two groups for their different futures but also in reducing the problems in planning, teaching and learning of mathematics. Moreover, if the programs are separated, writing texts would be much easier.

As a footnote, it is worth adding that, during the heyday of 'modern mathematics', most countries ignored that distinction and produced only <u>one</u> curriculum that leaned heavily towards the needs of the **college-prep** students. The subsequent difficulties experienced by the non-college-prep students led the educators to rethink the matter in a more **realistic** way. As a result, since around 1980 many countries offer alternative curricula tailored to the needs of the students.

Computers

In 1984 the Fiji Education Department introduced computer education in the secondary school. This reflected a need for technological advancement of the people of Fiji as well as a world-wide educational trend (Pal, 1988). However, there is a need to look deeply into various aspects of computer education offered in the Fiji schools, especially since it is a very new area and calls for a large investment in equipment.

The Form 7 prescription has an optional section on computer education. The knowledge of computers is to be gained via two projects which together contribute only 5% of the total year's work in mathematics. The knowledge gained could be extremely useful but also extremely elementary. It is my view that it would be better to introduce computer education in Forms 5 and 6.

A knowledge of computer programming would be extremely useful in jobs since the vast majority of Form 6 school leavers enter the job market. Since some schools may not have computers, computer education needs to be made optional until about 1995. However, computer education should be **tested** in the Form 6 external examination (FSLC) as an optional question. The prescription should require about 15 hours of 'hands-on' programming by each student.

No doubt this is a rigorous agenda. However, it will ensure that the time of the students and the teachers and the money invested in the equipment, space, etc., are well used. It would go a long way in ensuring also, that many Form 6 school leavers emerge with a solid grounding in computing that is attractive to the employers or one that the Form 7 program can build on.

For the long-term future, however, some thought needs to be given to introducing <u>a subject called computing</u> (as distinct from computer education within mathematics). It might even be made compulsory for junior forms and tested in the Fiji Junior Certificate Examination. The senior forms could then study specific computing packages (e.g. the SAS) and word processing (e.g. wordperfect).

Assessment

The Department of Education is aware that its examinations need greater relevance and effectiveness. Therefore, in 1989, G. DeMauro, a consultant in assessment from the U.S.A., was hired to review 'the current techniques used in school and external examinations' (**The Fiji Times**, 19 August, 1989).

The writer is not aware of DeMauro's recommendations with respect to mathematics. Nevertheless, he offers the following brief constructive suggestions with specific reference to **mathematics** examinations - ideas that may help in making the mathematics examinations 'more relevant and effective'.

Both the Fiji Junior Certificate and the Fiji School Leaving Certificate Examinations in mathematics have parallel formats. Section A (40%) is composed of a set of multiple-choice questions and short-answer questions. Section B (60%) is composed of long answer questions.

While the first section is intended to test **basic skills** such as computation, recall, and knowledge, the long-answer questions are designed to test **higher level skills** such as understanding, analysis, synthesis, and application. However, the writer does not believe that much is gained by testing basic skills (Section A) via **both** multiple-choice and short-answer type questions. The only difference, perhaps, lies in the ease of scoring the multiple-choice answers. Therefore, one of the sub-divisions of Section A needs to be omitted. There is also a need to delete some basic skills type of questions from Section B to make it a more stringent test of the complex mathematical thinking that it is clearly designed to be.

If the multiple-choice format for Section A is retained, a choice should be added. To facilitate marking of such questions, a scanner could be bought. The use of such a machine would save valuable time and energy while improving the accuracy of the marking.

The questions in the second section of the examination need to be attended to as well. Where possible, a question should focus on one topic only rather than combine two topics together which may lead to many needless sub-divisions of the question. Moreover, superfluous pictures or diagrams need to be excluded.

In addition, some thought could be given to including **internal** assessment at the Form 6 level. Perhaps an independent project could be incorporated. Each student could select a topic for investigation and do a project on it.

It is worth adding here that, if the Forms 5 and 6 curriculum is split into college-prep and non-college-prep curricula as recommended earlier, then separate examinations will become much easier to develop. The proposed Form 6 projects could also be tailored more to the needs of the two types of students. For example, the non-college-prep students may focus on projects involving consumer mathematics.

Alternative models

In recent years, the orientations of Fiji are rapidly changing. The British, New Zealand and Australian models that were used in the commercial fields, for example, are now being replaced by models of economic development from South East Asia. The ideas from countries like Japan, Korea, China and Taiwan appear far more appropriate in terms of its economic development.

The authorities in Fiji could likewise borrow ideas for teaching/learning mathematics and science from those countries to improve the mathematics and science education in Fiji. The models of mathematics teaching/ learning from Japan and her neighbours may be more appropriate to the situations in Fiji - and for the mathematics development of the indigenous people - than the approach borrowed from New Zealand. Japanese mathematics and science achievement is very high by international standards and Korean students also do very well. For example, in a recent international test of 13-year olds' mathematics and science achievement, the Korean students ranked highest in both subjects - far ahead of the British, American and Spanish students. (**Time**, September 18, 1989).

It is worth adding that in a search for alternative models, attention need not be confined to South East Asia. Some attention should also be given to models from such places as North America, the European continent, East Africa, the Caribbean and the Soviet Union.

Can educators in Fiji lead education delegations to those countries - similar to the present trade delegations? Can some of the education leaders from those countries be invited to advise and help us on various aspects of (mathematics) education, such as teaching, learning, curriculum development, computer education, and assessment?

Further research

In trying to improve mathematics education nationally, some important decisions have to be made and priorities set. One therefore needs hard data on which to base one's decisions and priorities. The hard data can come only from research and this data would prove invaluable for the authorities involved in decision-making.

Against this background, the Ministry of Education could do much. It could develop a list of possible projects for research students at the universities, and support a PhD student's research project through small grants and/or data collection. The findings from such a study may help in further planning.

As well, the Ministry could start keeping records of the marks in public examinations by ethnicity and sex. This information could be made available for future research studies on high school achievement.

A comprehensive, nationwide study of mathematics teachers and teaching/learning problems needs to be undertaken soon. Such a study would be a **baseline** one; it could be used to compare future findings and to check improvements in various areas and for manpower planning beyond the year 2000; e.g., teacher education and training, class size, teaching resources, effectiveness of refresher courses, facilities for teaching computer education. Such a study needs to be undertaken at regular intervals. The mathematics skills assumed in learning science in each form may also be identified via such a study.

Since the establishment of the University of the South Pacific, there has been concern about the achievement of Fijian students relative to the achievement of Indo-Fijian students. For example, the Fiji Government's Scholarship Review Committee expressed 'deep concern' at the high failure rate of Fijian students in the Foundation Science program at the University (**The Fiji Times**, December 20, 1982, p.10). Post-coup developments have heightened this concern, yet research to provide some answers or to suggest solutions is sadly lacking. Studies could be undertaken to explore why the Fijian students are lagging behind in mathematics and science and to examine their strengths and weaknesses. Elley (1982) made a small beginning; other research can build on it.

A large, high-level body could be set up to conduct research and gather data. It should be independent of the Government and staffed by highly qualified professionals in several fields. It would be a central body in charge of conducting and co-ordinating research in education in the country. It would function along the lines of similar bodies overseas such as the Australian Educational Research Council and the New Zealand Council for Educational Research.

Conclusion

In this article the writer has suggested several directions for reforming secondary mathematics education in Fiji. It may take the following forms:

a) better integrating the curricula across the five-year high school program

b) giving more emphasis to algebra

c) writing/revising texts

d) re-examining computer education

e) providing separate curricula and examinations beyond Form 4 for those not likely to proceed to tertiary studies

f) improving the efficiency of external examinations

g) borrowing models of mathematics education development from diverse countries

h) doing more research.

If implemented, I believe those proposals could lead to some definite improvements in students' mathematics achievement.

Bibliography

Chief Examiner's Reports : *School Certificate Examination 1986 & 1987 (Mathematics and Mathematics S.P.O.).* Wellington: New Zealand Department of Education.

Crisis in the Science Classroom (1989) Time, September 18, 1989.

Elley, W. (1982) *Progress Report on 'Project on Fijian Education Achievement'.* Unpublished paper, the University of the South Pacific, Suva.

Examiner's Report (Mathematics), Fiji School Leaving Certificate Examination (1990). Suva: The Ministry of Education.

Examiner's Report (Mathematics), Fiji Seventh Form Examination, (1987). Suva: The Ministry of Education.

Fiji School Leaving Certificate Examination Prescription (Mathematics) (1989). Suva: The Ministry of Education.

Fiji Seventh Form Examination: Mathematics Prescription *(No date).* Suva: Ministry of Education.

Hill, S. (1976) *Issues from the NACOME Report.* Mathematics Teacher, 69, 440-446.

Kline, M. (1976) *NACOME: implications for curriculum design.* Mathematics Teacher, 69, 449-454.

Kline, M. (1973) *Why Johnny Can't Add: the Failure of the New Math.* New York: Martin.

McKnight, C.C. (1985) *Twelfth grade mathematics in the U.S. high schools: a Report from the Second International Mathematics Study.* Mathematics Teacher, 78, 292-400.

Pal, A. (1988) *PRINT 64: a User's Guide to the Commodore 64.* Suva: The Ministry of Education.

Prasad, B.S. (1988) *A Study of Factors Influencing the Mathematics Achievement of Year 10 Students in Fiji.* Unpublished PhD Thesis, University of Queensland, Brisbane, Australia.

Resnick, L.B. (1987) *Education and Learning to Think.* Washington D.C.: National Academic Press.

Stewart, R. (1982) *Fijian Education (Address to the Staff and Senior Students of Adi Cakobau School, Sawani, Fiji).* Unpublished paper, the University of the South Pacific, Suva.

The Fiji Times. December 20, 1982.

The Fiji Times. August 19, 1989.