3. THEMES AND ISSUES PERTAINING TO PRACTICE

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- *What are the mathematical competences that are required in the different professions ?*
- *What are students' attitudes and beliefs concerning mathematics ? What causes them to change ? How do these affect their enrolments and success in courses with substantial mathematical components ?*
- *What are the effects of the use of technology in the teaching and learning of mathematics ? In what ways can technology be used to enhance understanding ?*
- *What important issues are under-represented in the research literature and how can researchers be encouraged to work in these areas ?*

3. Themes and issues pertaining to practice

We divide this section into four parts: Clientele, Curriculum, Student activity, and Pedagogy.

Clientele

The students who are of interest for this Study include all those students who are taught mathematics at university level, whether as mathematics majors, as students of other subjects using mathematics as a service course, as prospective mathematics teachers, or as recipients of some form of general mathematics appreciation course. Hence we are addressing the needs of not only future research mathematicians but also other categories of future mathematics professionals as well as graduates in other disciplines who require varying amounts of mathematical knowledge, skill or insight.

For several reasons, in many countries there has been a move to mass education at university level. As a result many mathematics departments are providing courses for a much wider range of ability and needs than was formerly the case. Simultaneously with this increase in student numbers, there has been a change in the kind of student preparation in secondary schools as well as in students' interests and motivation. Consequently many students have not met material which was in most secondary school curricula of the 1970s. In addition they may have been taught by an approach which places more emphasis on the intuitive and pragmatic. Some university mathematics departments have been slow in recognising these changes in their student intake. Others have developed new courses to cope for the range of content needs but have made few pedagogical concessions.

There are a number of special groups of students including potential teachers of school mathematics, scientists, engineers. What should the interaction between mathematical and professional knowledge be ? To what extent do these groups need specially designed courses ?

Curriculum

By curriculum we mean matters pertaining to the purposes, goals and content of mathematics education. Current curricula may need to be reconsidered for at least two reasons. There are the different student needs that were mentioned above and there are the developments in mathematics itself.

As far as the changing clientele is concerned, it is not clear that its constitution or its needs have been adequately considered. What are the professional aspirations of our student population? Will they go on to be teachers, to work in industry, to be academics, etc.? How should the curriculum be shaped to meet the needs of these groups?

What changes are, or should be, taking place in the curriculum? Some mathematical subject areas are on the decline while others are in the ascendancy. What is the rationale for the changes? Are some content areas now less important and should other areas take their place?

Mathematics as a rapidly developing research field is continuously undergoing changes with new fields arising, changes of emphasis, and so on. At present we notice strong interactions between different branches, an increasing interest in applications, the development of an experimental approach, etc. To what extent is and should this evolution be reflected in the teaching of the subject at undergraduate level?

Student activity

Here we wish to discuss the various ways in which students might be induced to interact with mathematical content, both inside and outside the classroom. What forms of study and what activities are currently used in the teaching of mathematics? Do different forms of engagement (e.g., in "mathematics labs" where students explore families of mathematical objects using computers) have the potential to result in better learning in different subjects?

Two of the central issues here are the role of the student and the attitude towards the subject. Under what circumstances should the student's role be to receive information and when should it be to interact with the content in more dynamic ways (including exchanges with their teachers and with other students)? Under what circumstances should the subject be presented as a set of skills (algorithms), as a set of processes or as a combination of these? The attitude of the teacher will require different reactions and actions from students.

Pedagogy

By pedagogy we mean the teachers' orchestration of teaching and learning environments and situations, examined both from the descriptive/analytic position (what *is* the case?) and the normative position (what *ought to be* the case?).

Some areas of mathematics are met by students before they enter university and the approaches they have met in school may well be quite different from those which are common in universities. Mathematics majors, for example, have to meet a more formal approach to calculus/analysis. What are the best ways to effect this change of approach? But, given the changes in clientele referred to earlier, it is likely that the transition to university teaching poses problems for all students. How can the transition from school to university be best accomplished?

This raises the issue of the philosophical approach to the subject. Many courses appear to concentrate on content knowledge. The emphasis seems to be on learning certain algorithms or theorems and applying them in controlled situations. This hides the creative and problem solving aspects of the subject. Should more emphasis be placed on the way that mathematicians think and create? Should there be more emphasis on students' problem solving capabilities as opposed to their learning the results the subject produces ? How can the impact of problem-based lectures, the use of computers, project work and so on, be assessed ?

One of the issues that requires discussion is the importance placed upon teaching by universities generally. In many universities, promotion is based largely on research output, with teaching having a minor role. In such places, there is little incentive for academics to put more emphasis on their teaching. There are, of course, many academics who put quite a lot of work into their teaching. Should the profession, through its national bodies, show that it recognises the importance of teaching at the university level ?

Another relevant issue is, where and how do academics learn to teach ? Some universities have courses for their staff but these often do not go into any great depth in particular subject areas. Should more formal instruction be given and, if so, by whom and of what type ?

Now that there is relatively ready access to computers, graphical calculators and calculators, it is worth examining to what extent we can release our students from some of the drudgery experienced by past generations. How has the new technology changed the content and philosophy of the curriculum ? How can mathematics majors benefit from using computer technology ? How can majors in other subjects benefit ? Should existing programmes be delivered in the same way as in the past or can technology assist in the development of higher order skills or other more important skills ?

4. Themes and issues relating to policy

Policy issues naturally fall into two groups : those relating to society at large and those which are the concern of a specific university or university department.

Society

The amount of control that society, through its government, takes over its universities, varies considerably from country to country. In most countries, government provides the majority of the financial support for its universities. Hence, at least indirectly, government policies will affect individual departments. How are these policies formed ? What influence can and should mathematicians and mathematics educators have on them ?

The previously mentioned increasing number of students at the university level has, in many nations, occurred either explicitly or implicitly as the result of government policy. Is there cause for satisfaction with the result of this policy or is there a need to change or modify it in some way ?

The mathematical community is convinced of the importance of mathematics both for its own sake and for the contribution that it ultimately makes to society. It is not clear that society in general also holds this position. Perhaps it does not realise what it takes to generate the contribution mathematics can make. What does the mathematical community need to do to make society aware of the mathematical requirements of society and how these can be achieved ? What does the mathematical community need to do to make mathematics more visible in a competitive environment ? In what ways should society provide its citizens with the basic ideas and philosophy of mathematics and its impact on our lives, both from a philosophical and practical point of view ?