REPORT

OF THE WORKING GROUP INVESTIGATING

THE QUALITY AND QUANTITY

OF MATHEMATICS AND SCIENCE TEACHERS

NOVEMBER 1987

Acknowledgements

The Working Group wishes to acknowledge the help and co-operation of practitioners from all sectors of the Ministry in its investigation.

It also wishes to extend its appreciation for the invaluable work of the Executive Officer, Ms Jeannette Huxham, the Research Officer, Ms Jan Thomas and the Co-ordinator of the SCOPE Project, Dr. John Taylor.

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SUMMARY AND RECOMMENDATIONS

The Working Group's investigation was constrained by difficulties encountered in obtaining vital data relating to mathematics and science teachers. In particular, data was not available on the number of fully qualified mathematics and science teachers currently employed by the Ministry of Education and their teaching and other duties.

The Working Group believes that, although there were deficiencies in the data available to it, it has identified an urgent need for positive strategies to improve both the quality and quantity of mathematics and science teachers. The recommendations are aimed at:

(i) improving the data base on teachers qualifications and duties and the adoption of a coordinated policy for labour force planning across the Ministry;

(ii) increasing the supply of mathematics and science teachers both in the immediate and long term future and;

(iii) improving the quality of teaching in mathematics and science through appropriate preservice education and greater opportunities for retraining and professional development.

These recommendations need to be considered in conjunction with the strategies proposed by the Working Group on Education for Science and Technology.

1. ENSURING AN ADEQUATE DATA BASE FOR LABOUR FORCE PLANNING

During its investigation the Working Group recognised the urgent need for a co-ordinated policy for labour force planning across the Ministry. A number of problems were experienced by the Working Group in obtaining vital data on the supply of, and demand for, mathematics and science teachers. As a necessary initial step towards a coordinated policy the Working Group recommends:

R 1 That a reliable data base be established to identify serious shortfalls in the number of qualified teaching personnel within specific subject areas, such as mathematics and science. Further, that the data base be used as a framework for future planning in the supply of and demand for teaching personnel and for assisting in establishing the retraining needs within the existing teaching force.

II. ATTRACTING MATHEMATICS AND SCIENCE GRADUATES INTO THE TEACHING PROFESSION:

The Working Group recognises the importance of attracting more new mathematics and science graduates, a traditional source of teachers, to pursue careers in teaching. New graduates and other professionals within industry should be offered incentives to enter teaching.

The present career structure for teachers needs to be examined, and if necessary restructured to offer adequate flexibility and promotional prospects for mathematics and science graduates interested in moving between teaching and working in industry.

The following strategies are recommended:

R 2 That mathematics, physical science and computer science graduates be offered studentships to enter teacher training.

R 3 That flexible career paths for potential mathematics and science teachers be developed and specific incentives explored to encourage experienced teachers to pursue roles as curriculum leaders in mathematics and science.

R 4 That the credit system for industry experience established for teachers entering Technical schools at assistant class level be investigated for all post-primary teachers. Further, that ways of incorporating industry experience into teachers career paths be explored. (Refer 5.4 and R 10)

III. IMPROVING THE PRESERVICE AND PROFESSIONAL DEVELOPMENT OPPORTUNITIES FOR PRIMARY AND POST-PRIMARY MATHEMATICS AND SCIENCE TEACHERS

The Working Group identified the need to improve the current preservice education structure for both primary and postprimary teachers. Current practices in the employment of primary teachers require examination to remove the disincentive for these teachers to continue studies in mathematics and science.

The Working Group considers it important to ensure that qualified mathematics and science teachers should be encouraged to remain within the teaching service and upgrade their skills and qualifications. Teachers within other disciplines should also be encouraged to undertake retraining courses in mathematics and physical sciences. The following strategies are aimed at primary and post-primary teachers.

R 5 That preferential employment in primary schools be offered to primary teachers with significant mathematics and science components within their preservice education course.

R 6 That the implementation of the recommendations in the report Primary Concerns (1985)[1] be monitored with regard to preservice programs for primary teachers. (Refer Appendix 5)

R 7 That subject tags for mathematics and science be introduced and encouraged for all primary schools. (Refer 5.3)

R 8 That the retraining of unemployed primary teachers as post-primary mathematics and science teachers be continued.

R 9 That consultations be held with the Victorian Post-Secondary Education Commission on:

(i) improving the preservice education of post-primary teachers through examination of course methods, practicum and duration; and

(ii) establishing and extending certificate and post-graduate courses that meet the needs of experienced teachers undertaking further training.

R 10 That as a long term objective teachers should be provided with opportunities to gain industrial experience as part of an overall professional development program.

R 11 That study leave awards be available to teachers who undertake retraining in areas of shortage, especially where a significant practical component is involved. (Refer 2.3.2)

R 12 That a review of subject tag requirements for post-primary mathematics and science positions be undertaken with a view to establishing tags appropriate to current curriculum and introducing a junior mathematics tag.

R 13 That programs be developed to assist mathematics and science coordinators to upgrade their skills and knowledge in order to provide stronger leadership in mathematics and science departments in post-primary and primary schools.

1. Primary Concerns, Owen, J. M. et al, Commonwealth Tertiary Education Commission, Canberra, 1985

R 14 That an appropriate number of mathematics and science consultants positions be established to facilitate an adequate professional development program in mathematics and science.

IV. ENSURING AN ADEQUATE FUTURE SUPPLY OF QUALIFIED MATHEMATICS AND SCIENCE TEACHERS

In the long term the Working Group considers a coordinated approach to labour force planning across the Ministry is essential to ensure the future supply of qualified mathematics and science teachers. However, it has identified a few specific strategies which could provide additional mathematics and science teachers in the immediate future.

There is a current imbalance in the number of teachers taking up industry positions as opposed to industry personnel going into teaching. The Working Group also believes that more women could be attracted back to teaching, including those on Family Leave, if more flexible employment opportunities could be generated. No study has been conducted on the number of overseas trained, non-English speaking background teachers who could be employed if offered suitable English language instruction and an introduction to the Victorian education system.

The Working Group therefore recommends:

R 15 That graduates from industry be trained for teaching through the expansion of courses such as those at Hawthorn Institute of Education. Further, the implementation of R 4 be seen as a mechanism for attracting both industry graduates to teaching, and teachers in industry back into teaching.

R 16 That the introduction of part-time appointments, especially for women who provide valuable role models in mathematics and science, be investigated and that particular attention be given to the possibility of job sharing.

R 17 That a study be undertaken into the potential pool of non-English speaking background teachers and their training needs as potential mathematics and science teachers.

1.0 BACKGROUND

1.1 Introduction

The shortage of suitably qualified mathematics and science teachers has been a long term problem experienced by many nations. The emergence of technological development as a key factor in economic growth and stability has created greater worldwide demand for graduates with specific expertise in mathematics, science and technology. This in turn has exacerbated the problem of an adequate supply of mathematics and science teachers. Graduates in these disciplines are attracted into business and industry by higher salaries and career opportunities thereby decreasing the already contracted pool of potential teachers.

The adequate supply of qualified mathematics and science teachers to meet demand has been a problem experienced by many countries, as the Cockroft Report,[2] Mathematics Counts (1982) clearly indicates. This problem is also being experienced in many Australian states. The report on Teachers for Mathematics and Science[3] by the Queensland Board of Teacher Education (1985), addresses the shortages of these teachers and shows that the problem is not unique to Victoria.

The Victorian Government in its second economic strategy statement, Victoria: The Next Decade[4] (1987), has reiterated the need to broaden and strengthen the mathematical, scientific and technologically based skills of the Victorian workforce "essential for the development of higher value added, more technologically advanced export and import replacement industries." One of the obstacles to the achievement of this aim, however, is a significant shortfall in the supply of adequately trained post-primary mathematics and physical science teachers[5] to meet existing and projected demands.

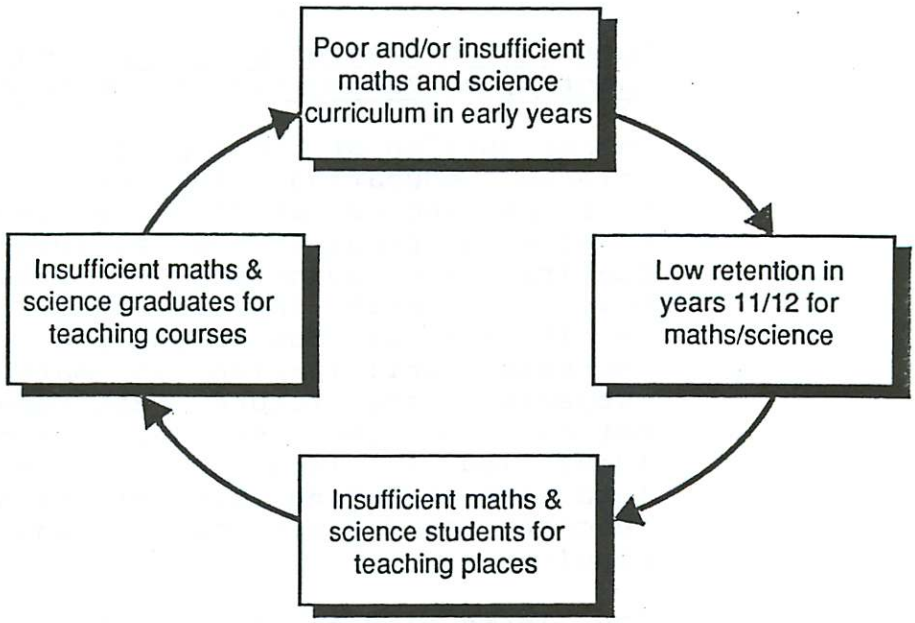
2. Mathematics Counts, Report of the Committee of Inquiry into the Teaching of Mathematics in Schools under the Chairmanship of Dr. W.H. Cockcroft, HMSO, London, 1982

3. Teachers for Mathematics and Science, Board of Teacher Education, Queensland, 1985.

4. Victoria: The Next Decade, Victorian Government Printer, Melbourne, 1987, pg. 81

5. Ibid, pp86-87.

A popular perception of the problem illustrates its cyclical and self-perpetuating nature, and can be represented thus:



Improving the quality and quantity of mathematics and science teaching involves breaking the cycle at some, or all points in the cycle. One realistic point for this to occur is with the curriculum offerings at the school level. The curriculum content and methodology are critically important in forming students' attitudes to mathematics and science in the early primary and post-primary years. These issues have been addressed by the Working Group on Education for Science and Technology. This Working Group has developed a range of strategies to encourage students to participate in mathematics and science so that the needs of both education and industry can be met. It recognised the importance of the quality and quantity of mathematics and science teachers, particularly with regard to the effective implemention of its recommended strategies and it has addressed the adequate supply of these teachers by developing strategies for improving the career structure as a whole and offering specific incentives.

There are therefore many areas of common interest between the Working Group on Education for Science and Technology and the Working Group on the Quality and Quantity of Mathematics and Science Teachers and the recommendations of both groups complement and support one another.

1.2 Formation of the Working Group on the Quality and Quantity of Mathematics and Science Teachers

In recognition of the implications for mathematics and science education in the Government's economic strategy, the Education Executive Committee established a working group in August, 1986, to investigate the quality and quantity of mathematics and science teachers. With the introduction of the Victorian Certificate of Education and Ministry policies to increase participation in mathematics and science subjects, the future requirements for qualified mathematics and science teachers needed to be identified for long term planning. An investigation into the existing level of mathematics and science teachers coupled with current and potential demand was required.

The Terms of Reference for the Working Group were to explore:-

(i) the current supply and demand for mathematics and science teachers and future projections

(ii) the patterns of in-service training available to mathematics and science teachers; and

(iii) possible refresher and retraining programs.

The Working Group was requested to frame broad terms of reference for longer term planning for primary and post-primary schools, with a specific emphasis upon the participation of girls in the mathematics and science area.

Members of the Working Group were:-

MR BERNARD RECHTER (Convener)	General Manager, (Portfolio Policy Coordination Division)
DR JOHN OWEN	Centre for Program Evaluation, (Melbourne CAE) (Representing VPSEC)
DR TIM MATTHEWS	Portfolio Resources Coordination Division
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The Working Group was supported by:

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1.3 Quality and Quantity

The Working Group addressed the issue of quantity by examining the current supply and future demand of mathematics and science teachers, whilst approaching the quality issue through an examination of the preservice, retraining and professional development requirements. These two issues are presented for the purposes of this report, as separate and distinct. In practice, however, these issues are interrelated and impinge upon one another. For example, a school which is unable to obtain an appropriately qualified mathematics and/or science teacher is forced either to allocate unqualified mathematics and science staff to junior classes, or reduce the curriculum offerings. Similarly, mathematics and science teachers disenchanted with the lack of career opportunities in their profession are opting to resign in increasing numbers, further exacerbating the shortages in these areas.

The Working Group has recognised this interrelationship and considers that an appropriate supply of mathematics and science teachers is essential if an improvement in the overall quality of teaching in these subjects is to occur.

2.0 CURRENT SUPPLY OF MATHEMATICS AND SCIENCE TEACHERS

2.1 Introduction

In addressing the initial term of reference - to explore the current supply and demand for mathematics and science teachers and future projections - it was necessary to initially identify the source and quantity of the existing supply of mathematics and science teachers. Government, Catholic and Independent school sectors all draw from the same potential and existing supply of mathematics and science teachers. This report predominantly describes the situation in government schools, but recognises the need for co-ordinated planning across all sectors.

The Working Party identified four distinct sources for the supply of qualified mathematics and science teachers in post-primary schools.

(i) New graduates from Diploma in Education and concurrent teacher pre-service courses at tertiary institutions.

(ii) Retraining of primary teachers and other professions through courses offered by Victoria College and Hawthorn Institute of Educations.

(iii) Existing mathematics and science teachers.

(iv) Recruitment from overseas and industry and employment of emergency teaching staff.

2.2 New Graduates

The traditional source of mathematics and science teachers is new graduates from universities and colleges of advanced education. The majority of additional mathematics and science teachers for all schooling sectors are provided from this source. Within the government sector 61% of mathematics and Science teachers employed during the period January to June 1987 were new graduates.[6]

6. Teaching Service Employment Statistics, Ministry of of Education, July 1987

The Working Group found that there is widespread concern in the tertiary sector about the low number of students presenting for some teacher training courses, especially in known areas of shortage such as mathematics and science. In 1987 teacher training institutions all reported increasing difficulty in filling mathematics and science places. In the last two to three years there has been a significant downward trend in Dip.Ed. enrolments for mathematics and science methods. Appendix 1 identifies enrolments in several tertiary institutions between 1984 to 1987 to highlight this trend. Most students represented in the figures pursue studies in two methods.

Appendix 1 demonstrates that the number of graduates proceeding to Dip.Ed. studies after graduation in maths/science is falling and this is reflected in a fall in the total number of Dip.Ed. students. Melbourne C.A.E. reported that there had been a fall in applications for all postprimary methods except music.

Appendix 2 presents the number of enrolments in the final year of some four year concurrent courses for teaching.

Enrolments in the final year of the four year concurrent courses are relatively stable compared with the Dip Ed Enrolments, although significant falls have occurred at Melbourne CAE in 1987. As these are four year courses, a decline in enrolments would first appear in new first year enrolments and should be closely monitored.

Appendices 1 and 2 reflect the downward trend in the number of graduates from teacher training courses able to teach science and mathematics. This data gives a further indication that the potential pool of newly qualified mathematics and science teaching staff is decreasing.

2.3 Retraining within the Existing Teaching Force and other Professionals

Another source of potential mathematics and science teachers is through the retraining of primary teachers into post-primary mathematics and science specialists and in upgrading the skills of current post-primary teachers. Suitably qualified professionals within industry are another valuable source of potential teachers, provided teaching can be perceived to be an attractive career option. Greater inducements could be offered to attract more professionals from industry to enter the career of teaching. This potential pool has only begun to be tapped.

2.3.1 Primary Teachers

The retraining of unemployed primary teachers to fill vacant post-primary mathematics and science positions has been pursued by the Ministry of Education. However, these retraining courses may need to be expanded. In the first half of 1987, some sixty-three primary trained teachers completed a retraining course in mathematics and science methods, conducted by Victoria College. The College offers a B.Ed. Special Program for the retraining of these primary trained teachers. Further teachers will be completing this retraining course later this year.

2.3.2 Post-Primary Teachers

Within the post-primary sector, technical teachers with skills in particular trade subjects, and teachers with a biology background are retraining as mathematics and physical science teachers. The Hawthorn Institute of Education has established a Bachelor of Education (Teaching Studies) specifically for retraining technical trade teachers.

Teachers with a biology background are in plentiful supply in comparison to mathematics and physical science and could be encouraged to upgrade their skills to teach physics and chemistry. Other areas of shortage in which these teachers could be retrained are mathematics, geology and computer studies.

This upgrading of the skills of post-primary teachers is beginning to occur. There is considerable ancedotal evidence that many teachers are interested in upgrading their skills in these areas.

The tertiary institutions report many enquiries for such courses and a group of women have organised their own course to improve their physics teaching skills at Holmesglen College of TAFE.

It is suggested that a range of courses be considered, in consultation with the client group, and that they be both certificate level and one year full-time post-graduate level (PG1). Certificate courses should be structured so that there is encouragement to complete a full PG1 course. There is support for this suggestion with a Monash course being run this year for those who wish to meet the tag requirements for mathematics.

This course will count for one third of a B.Ed. (Refer R9).

However, the major barrier to the retraining of post-primary teachers is the lack of study leave.

There is therefore a need for study leave awards to be granted for these retraining courses. In the case of subjects such as physics, where a substantial practical component is involved, it is virtually impossible for full-time teachers to consider them. It is considered that, if study leave was available the demand would far exceed the number of awards. Accordingly, those selected could be expected to be teachers with a record of achievement and potential for leadership within their schools. It is therefore considered that the awards should be made for the full PG1 course to enable these teachers to also gain insight into recent educational theory and practice that would support them as curriculum leaders in their schools. The Working Group considers this to be one way in which more women could achieve roles in schools that supported the participation of girls in the physical sciences and mathematics. (Refer R11).

Specific initiatives undertaken by the Government, and outlined in Victoria : The Next Decade, includes a limited number of study leave awards for teachers retraining in these subject areas. The Working Group consider this initiative should be extended to encourage teachers to retrain in mathematics, physical sciences and computer science.

If appropriate study leave can not be granted to all teachers who are undertaking further studies in areas of shortfall, then it is suggested that the possibility of reducing time fractions for these teachers should be examined. This would be the equivalent of a permanent part-time position but only for the duration of the course.

2.3.3 Other Professions

The mathematics courses offered at Hawthorn Institute of Education in the last few years have shown that people can be attracted into teaching from other professions. Such people who are attracted from other professions are particularly valuable because of their industrial knowledge and expertise. The response to courses such as the

one at the Hawthorn Institute indicates that there is a pool of such people available, which could be increased with Ministry initiatives.

The Working Group consider that courses such as those offered at Hawthorn Institute of Education should be expanded. (Refer R15)

2.4 Existing Mathematics and Science Teachers

The Working Group attempted to identify the number of qualified mathematics and science teachers currently teaching in government schools. This data is essential to firstly, measure the existing teachers within government schools and secondly, identify the current shortage.

The data available to the Working Group did not identify the qualified mathematics and science teachers, or the actual numbers of effective full-time teachers in mathematics and science. A serious lack of co-ordination within the Ministry has led to the breakdown in this data collection over the last few years. For this reason the Working Group sees the collection of this data as having the highest priority (Refer R 1).

2.5 Recruitment and Employment of Emergency Teaching Staff

In the past shortages in specific subject areas have been overcome with the employment of contract teachers from overseas. This contract system no longer operates, although some teachers are recruited through an employer nomination scheme. The quota for this type of recruitment has recently been increased from twenty-five to thirty-five.

Vacancies within government schools for mathematics and science teachers, are filled by the employment of emergency teaching staff as a short term measure. The following table indicates the level of employment of new mathematics and science teachers, some of whom are recruited as new graduates and a few from overseas. It also indicates the numbers of extended emergency teachers (E.E.T.'s) being employed by the Ministry to fill long term vacancies.

TABLE 1: Employment of new Mathematics and Science Teachers each year - 1985 and 1987 by Ministry of Education

Year	Permanent	E.E.T.'s (1)	Total
1985	727	207	934
1986	497	321	818
1987 (June 1987)	468	96	564

Note: (i) It is Ministry policy that E.E.T.'s not be employed until beginning of term 2. This figure fluctuates throughout the year, reflecting the availability of these teachers and the Ministry Staffing policy.

(ii) 1988 and 1989: estimated that a total of 800 teachers will be required to fill permanent and short-term vacancies.

Source: Staffing Section, Ministry of Education, 1987.

The availability of permanent and part-time teachers to fill mathematics and science vacancies in schools is severely limited. The following table illustrates the limited pool of available mathematics and science teachers, including new graduates.

TABLE 2: Mathematics and Science Teachers Currently Registered for Employment as at August, 1987

Subject Areas	Full Time	Part Time	Total (1)
Mathematics and Physical Science	27	27	54 (8)
Science and Biology	8	13	21 (4)

Note: (1) Numbers in brackets are new graduates within these totals.

Source: Recruitment Statistics, Human Resources Branch, Ministry of Education.

The problem of meeting the demand for mathematics and science teachers is further exacerbated in specific schools. The demand for mathematics and science teachers is subject

to geographical variation. Rural isolation and socio-economic factors affect the demand for mathematics and science teachers.

The majority of the mathematics and science teachers currently available for employment shown in Table 2, were only prepared to teach in some metropolitan areas. Only five of these teachers were offering to teach in country areas.

Emergency teaching staff are also employed to cover vacancies of teachers on leave and those who resign permanently from the service. Those teachers on long term leave ie: family leave, long service leave, 12 months leave without pay, eventually return to their teaching positions and must not be considered part of the permanent shortfall.

3.0 CURRENT DEMAND OF MATHEMATICS AND SCIENCE TEACHERS IN GOVERNMENT SCHOOLS

3.1 Introduction

The Working Group experienced a number of difficulties in identifying the actual demand for mathematics and science teachers. Its investigation was hindered by the lack of a central, coordinated data base within the Ministry which could reliably predict the level of demand in any given subject. (Refer R 1)

The Working Group identified that a number of shortages for mathematics and science teachers were hidden. It was found that long term vacancies for mathematics and science teachers in post-primary schools are being absorbed with the use of unqualified teachers to teach junior mathematics and science classes.

Shortages are also being absorbed in schools with a decrease in the amount of time devoted to mathematics and science in years 7-10. The Working Group was not able to identify the extent of these hidden shortages. However, the following table gives a strong indication that schools are absorbing shortages.

TABLE 3: DECREASE IN THE AMOUNT OF TIME DEVOTED TO MATHEMATICS AND SCIENCE IN YEARS 7-10 IN GOVERNMENT POST-PRIMARY SCHOOLS

	Mathematics			Science	
Year	1981		1987	1981	1987
	240 Mins or more %	Less than 200 mins %	Av. Mins. Per Week	Av. Mins Per Week	Av. Mins Per Week
7	58	6	193.2	152.6	144.4
8	54	6	194.9	155.8	146.0
9	53	7	192.7	162.0	150.9
10	54	11	196.3	170.3	162.9

Source: Staff Duties Analysis 1987.
Science curriculum and resources survey 1980-1982.
Survey of Mathematics programs and resources 1981-1982.

Note: 1. Methods of data collection for 1981 and 1987 are not directly comparable. 1981 mathematics sample covered a majority of post-primary schools. 1981 science data represents a significant sample.

2. The mathematics data and science data for 1987 is derived from a survey of all schools and represents the mean for Victorian government schools.

Table 3 indicates a significant decrease in the amount of time devoted to mathematics between 1981 and 1987. For instance fifty eight per cent of year 7 mathematics classes were of 240 minutes or more of tuition in 1981 whereas in 1987 the Victorian average had declined to below 200 minutes. A decrease is also evident in the amount of time devoted to science in the total curriculum.

Taking these difficulties into consideration, the Working Group identified a number of factors which combined, give some indication of the current demand in primary and post primary schools. These factors include (i) the number of reported vacancies in post-primary schools for mathematics and science teachers; (ii) the level of total teacher cessations including family leave, resignations and retirement; (iii) the reduced curriculum offerings and (iv) the number of emergency teachers employed. These factors are also supported by a range of anecdotal information.

3.2 Primary Schools

As the primary school curriculum is not organised into discrete subject areas it is far more difficult to ascertain demand for teachers skilled in mathematics and science teachers. There is anecdotal evidence of a shortage of primary teachers with sufficient expertise in mathematics and science to provide curriculum leadership in their schools.

In addition, there is evidence that very little science is taught in most primary schools. Thus, students often enter post-primary school with little formal orientation to a scientific view of the world[7].

It has been found that science programs in primary schools seem to be far less developed than mathematics programs, and there appears to be a special need for support to upgrade the status of science in schools.[8]

7. Primary Concerns, Owen, J. M. et al, Commonwealth Tertiary Education Commission, Canberra, 1985

8. Ibid, pg. S-4 (refer Recommendation 1-1)

3.3 Post-Primary Schools

3.3.1 Number of reported vacancies for Mathematics and Science Teachers

The reported vacancies in schools, provided by Staffing Section of the Ministry, represents long term vacancies in particular schools occurring through resignations, retirement or long term shortage. The total unfilled vacancies obviously fluctuate throughout the year and between years. However, in April 1986, there were sixty eight vacancies in mathematics and science which could not be filled, even with emergency teaching staff. In August 1986, the ongoing vacancies had increased to one hundred and forty. In April 1987, seventy eight vacancies for mathematics and science teachers could not be filled.

It is difficult to ascertain the accurate level of demand for mathematics and science teachers from these fluctuating numbers of ongoing vacancies. Such vacancies do indicate however, that permanent shortages which cannot be filled, exist in some schools. The Staffing Report in August, 1987 identifies vacancies for mathematics and science teachers which have existed since April last or earlier.

The Staffing Section of the Schools Division receives many complaints from schools unable to obtain mathematics and science teachers. This level of dissatisfaction amongst schools combined with the following anecdotal information does provide further evidence that demand exceeds supply.

- The vacancies for qualified mathematics and science teachers advertised in the press by schools.
- The numbers of mathematics and science staff eligible for long service leave and for whom no replacements can be found.
- Junior mathematics classes being allocated to teachers with no specific training in mathematics.
- The Science Teachers' Association (STAV) survey showing a decrease in the amount of time devoted to teaching science in post primary schools.

The Working Group is conscious that these factors are anecdotal in nature however, considers they indicate the existance of a serious problem.

The Science Teachers' Association of Victoria conducted a survey of post-primary schools in 1985 (Appendix 3). In 1985, of the 172 schools responding to the survey, state high schools were spending 146 minutes per week on science in year 7 while in 1980 they were spending 170 minutes per week on science. The Australian Science Teachers' Association recommends that 180 minutes should be spent per week teaching science.

The decision to decrease the amount of time devoted to science at Year 7 appears to be not only a curriculum decision but also as a means of absorbing the shortage of mathematics and science teachers.

Similarly in primary schools, a survey conducted by the Primary Science Task Force in 1986 indicated that fifty eight percent of schools spent between 30 - 60 minutes per week teaching science, while 14% only spent less than 30 minutes a week. (Refer Appendix 4).

This information, combined with the number of reported vacancies and the number of Emergency Teachers in mathematics and science being employed each year, indicates that the current demand for permanent mathematics and science teachers, exceeds supply.

3.3.2 Level of Teacher Cessations

The available data on the total teacher cessations for 1984-1986 indicates a steady rise amongst post-primary teachers. Primary teacher cessations have also risen but remained low in comparison to the rate of post-primary cessations.

The increase in teacher cessations between 1984 - 1986 in both primary and post-primary areas is indicated in Table 4. These figures represent the cessations due to retirements and resignations and do not include those teachers on Family Leave.

TABLE 4: Primary and Post-Primary Cessations of Teachers in all Subject Disciplines between 1984 - 1986

	1984	1985	1986
Primary	560	614	885
Secondary	839	1,119	1,199
Technical	508	491	633
	1,907	2,224	2,717
Total Post-Primary	1,347	1,610	1,832

Source: Compendium of Statistics, Schools Division, 1986 and 1987

1987 Cessations:

An analysis of cessation data from February to May showed that post-primary teachers dominated many of the twenty-one categories of reasons for resigning. Primary and post-primary teachers were equally represented in retirement categories, and in resignations due to ill-health, or domestic reasons. Post-primary teachers constitute a majority of the resignations due to (a) travel, (b) to teach elsewhere; (c) full-time study; (d) personal reasons; (e) dissatisfaction; (f) other/no reason and (g) other employment.

A further analysis of these categories of post-primary cessations occurring in February 1987 shows that mathematics, science and computer science teachers are the largest subject group. Table 5 below shows the February sample of cessations in the eight reason categories relating to post-primary teachers. Table 5 clearly shows that a significant number of mathematics, science and computer science teachers are resigning to pursue other employment.

TABLE 5: Cessations of Post-Primary Teaching in February 1987 by Subject Category

REASON (i)	SAMPLE SIZE (ii)	MA/SC/CS	EN/EM	HE	ARTS INCL. MUSIC	COMM.	PE	OTHER
I/S travel	37	6	11	8	0	3	3	6
O/S travel	25	9	8	6	0	0	1	1
Teach elsewhere	37	19	8	3	1	4	1	1
Full-time study	22	5	5	4	2	1	3	3
Personal reasons	44	16	9	6	4	3	2	4
Dissatisfaction	15	8	4	1	1	0	0	1
Other/no reason	70	22	14	9	4	3	3	15
Other employment	110	42	17	14	7	7	8	15
TOTALS	361	127	76	51	19	21	21	46

Source: Raw Data from 1986 Staff Duties Analysis and Cessation data supplied by Schools Division.

Notes: (i) Reasons derived from 21 categories on Teacher Resignation Form for Schools Division.

(ii) The sample represents only teachers who could be identified within subject categories and does not represent all cessations occurring in February.

The steady increase in the number of resignations amongst mathematics and science teachers to pursue other employment raises the issue of job satisfaction and the appropriateness of the career structure for the teaching profession.

TABLE 6: Cessations of Post-Primary Teachers in February 1987 by classification

Reason	Sample Size	Ass. (Sec)	Ass. (Temp) (Sec)	Ass. (Tec)	Ass. (Temp) (Tec)	Sen. (Sec)	Sen. (Tec)	Ass. (POR)
I/S Travel	37	13	17	4	3	0	0	0
O/S Travel	25	11	9	2	3	0	0	0
Teach Elsewhere	37	15	14	4	3	1	0	0
Full/Time Study	23	15	8	0	0	0	0	0
Personal	44	26	10	5	2	0	0	1
Dissatis-faction	15	5	5	3	0	1	0	1
Other/no reason	70	25	23	6	14	0	2	0
Other Employment	110	56	25	15	14	0	0	0
TOTAL	361	166	111	39	39	2	2	2

Source: Raw Data from 1986 Staff Duties Analysis and Teacher Cessation Data supplied by Schools Division

Abbreviations: Ass - Assistant Classification: Secondary/ Technical

Ass. (POR) - Assistant Class with Position of Responsibility.

Sen-Senior Teacher Class

Table 6 indicates that the majority of post-primary teachers resigning from the teaching service in February 1987 were Assistant Class teachers. This data implies that teacher resignations are occurring due to dissatisfaction with the career structure for teachers.

The issue of the career structure for teachers has been addressed in more detail by the Working Group on Education for Science and Technology. It is considered to be a major reason for new mathematics and science graduates rejecting teaching as a career option as well as the increased resignations of existing mathematics and science teachers.

Information on the Advanced Offers of Employment for 1986/87 offered by the Ministry supports the perception that teaching is unattractive as a career. Twenty graduate applicants were made an offer with the payment of a $2,000 gratuity to accept a position to any post-primary school in Victoria, and only six graduates accepted this 'Super Advanced Offer'.

Whilst it is not possible to measure the exact level of demand for mathematics and science teachers, there are indications that a serious problem exists. The reduction in the amount of time devoted to mathematics and science classes in schools and the trend of teacher cessations in mathematics and science are a cause for concern.

4.0 FUTURE DEMANDS FOR MATHEMATICS AND SCIENCE TEACHERS IN GOVERNMENT SCHOOLS

4.1 Enrolment Projections and Teacher Demand

The difficulties experienced by the Working Group in identifying the current demand for mathematics and science teachers were exacerbated in attempting to measure future demands. The Consultative Group on Teacher Supply and Demand has also expressed concern about the insufficiency of data in the supply of, and demand for, subject specialist teachers.[9] The dynamic, changing nature of educational requirements at the present time, with the introduction of the Victorian Certificate of Education and its possible effect on student participation, also make accurate predictions for teaching personnel difficult.

These difficulties are recognised in a recent Commonwealth Tertiary Education Commission and Commonwealth Schools Commission report Improving Teacher Education, 1986 which acknowledges that "labour market forecasting is a complex exercise which is subject to considerable variability".[10] The report goes on to state that : "Projections of teacher requirements are extremely sensitive to changes in the determining factors, principally enrolment projections, wastage rates and pupil/teacher ratios".[11]

The Working Group assumed that in measuring the future demand there is unlikely to be major changes to current pupil-teacher ratios or class sizes and that wastage rates[12] are subject to so many variables that it would be very difficult to make any predictions about them.

The impact of the introduction of the VCE and the increased retention to Year 12 are further complicating factors in determining future demand.

9. 'Advice on Planning Teacher Supply and Demand for Schools in Victoria', A Report by the Technical Committee on Teacher Supply and Demand, April, Ministry of Education, Victoria, 1986

10. Improving Teacher Education, Commonwealth Tertiary Education Commission and Commonwealth Schools Commission, Canberra, 1986, pg. 11

11. Ibid. pg. 11

12. Wastage Rates refers to teacher cessation including resignations, retirements and long term absences such as family leave, long service leave etc. However family leave is often not considered "wastage".

4.2 Participation rates in Mathematics and Science

Dekkers, De Laeter and Malone (1986) published data on enrolment patterns in mathematics and science in the upper secondary schools in Australia.[13] This enrolment data indicates retention in Australia has been rising from 37% in 1982 to 46% in 1985. Similarly, enrolments in various science subjects has reflected this overall increase but not at the same rate. Whilst the percentage of students completing Year 12 has increased, this has not been matched by a corresponding increase in the number of students studying science subjects.

In general, Victorian trends parallel those in the rest of Australia although participation in mathematics and science in Victoria tends to be amongst the lowest in Australia, particularly at Year 12. A more detailed analysis has been prepared by Taylor for the Working Group on Education for Science and Technology. Some analysis of curriculum offerings and participation across Australia has also been undertaken.

The SCOPE data (Appendix 6) indicates that 90% of all students participate in some mathematics in Years 11 and 12. However, only about 80% undertake some science, even when computer science, computer studies and technological studies (which includes practical technical subjects) are included.

In the analysis conducted by Taylor participation rates for all 1986 Victorian students were calculated from the SCOPE data to simulate the proposed VCE Fields of Study in mathematics, science, technology studies and information technology. This analysis revealed that if science/technology had been mandatory in 1985 and 1986, twenty-five per cent more students would have been studying science/technology. The possible increase of participation in these subject areas may create greater future demand for mathematics and science teachers when the VCE is implemented.

13. Upper Secondary School Science and Mathematics Enrolment Patterns in Australia, 1970 - 1985, J. Dekkers, J.R. De Laeter and J.A. Malone, W.A.I.T., 1986.

4.3 Class Sizes in Years 11 and 12

A further pressure upon the demand for mathematics and science teachers from increased retention is the corresponding increase in the number of mathematics classes in Years 11 and 12 and the increase in the number of science/technology classes required. Taylor indicates in Appendix 6 that mathematics classes would be expected to rise by eight per cent and the number of science/technology classes by twenty-five per cent under current enrolment figures.

From 1985 data supplied to the Working Group presented in Table 7 below, it would appear that a significant increase in participation in Year 12 could be absorbed without creating additional classes. However, Year 11 class sizes appear to be close to the average of earlier years and additional classes would need to be created.

TABLE 7: Average Number of Pupils Per Class for Years 11 and 12 - 1987

SUBJECT	Year 11	Year 12
Mathematics	19.0	14.3
Computer Science	17.6	10.9
Chemistry	17.6	13.1
Physics	16.6	11.8
Biology	19.5	15.2

Source: Staff Duties Analysis, Statistical Information and Research Section, Policy and Planning Unit 1986.

If participation in Year 11 Mathematics and Science classes increases, the additional classes would place further pressure on the demand for qualified teachers in the future.

4.4 Amount of time devoted to Mathematics and Science within the Curriculum

Currently the proportion of time devoted to mathematics and science within the curriculum at years 7-10 in post-primary schools represents about twenty-three per cent of the total curriculum. This proportion is however the bare minimum required, particularly at the senior years, as it represents only 200 minutes per week of Mathematics and 150 minutes of Science per week per student.

The Science Framework, P-10 advocates policies developed in Australia and overseas which suggest that in Years 7-10 a minimum of 180 minutes per week should be spent

teaching science, whilst at Years 11 - 12 a minimum of 240 minutes per week should be devoted to science. The Working Group on Education for Science and Technology endorsed the Science Framework policy.

In 1987 the average time allocated to mathematics across the state was below 200 minutes for years 7-10 (refer Table 3). The following table indicates the number of extra mathematics and science teachers that would be required to increase the time allocated to these subjects. The following data does not imply that the total number of teachers employed at levels 7-10 should increase.

TABLE 8: Number of New Mathematics and Science Teachers Required to Improve Curriculum Offering in Mathematics & Science

YEAR	MATHEMATICS		SCIENCE	
	200 mins	240 mins	Return to 1981	180 mins
7	15	102	17	73
8	12	105	22	76
9	19	121	28	74
10	10	110	19	45
TOTAL NO. OF TEACHERS	56	438	86	268

Source: (a) 1987 Staff Duties Analysis - 1986
(b) 1986 compendium of statistics.

Explanatory notes:

$$\frac{\text{Additional minutes required}^{(1)} \times \text{No of students at year level}^{(2)}}{\text{Average class size}^{(3)} \times 960^{(4)}}$$

(1) Additional minutes required for mathematics was obtained from the difference between 200 (or 240) and state average for 1987 from Staff Duties Analysis. Additional minutes required for science was obtained from difference between 1981 figures (Table 5) or 180 mins and state average for 1987 from staff duties analysis.

(2) No. of students at year level was taken from **Statistics Bulletin,** No. 28, 20th May, 1987.

(3) Average Class size was taken from 1987 Staff Duties Analysis. Mathematics classes are bigger than average class sizes over all subjects and probably can not be increased further.

(4) It was estimated that each additional teacher would have 960 minutes of teaching time available for mathematics and science classes.

The data relating to the amount of time devoted to mathematics and science in the curriculum is tangible evidence of the way in which shortages of mathematics and science teachers can be hidden by reducing the curriculum offering in these subjects. Table 8 implies that approximately 300 additional teachers of mathematics and science are needed in government schools alone to ensure that all students in years 7-10 receive 200 minutes of mathematics and 180 minutes of science per week. The Working Group considers 200 minutes of mathematics should be considered a minimum offering and it is well below what the majority of schools was offering in 1981. Continued monitoring of the amount of time devoted to mathematics and science in the curriculum should be an important aspect of considerations relating to future demands for mathematics and science teachers.

5.0 PRESERVICE, AND PROFESSIONAL DEVELOPMENT REQUIREMENTS

5.1 Introduction

Whilst it is important to encourage new graduates to enter teaching by enhancing the attractiveness of teaching as a profession, it is equally important to retain the existing teaching staff.

The Working Group considers that to improve both the quality and quantity of mathematics and science teaching, those already in the profession must be encouraged to remain in teaching and given the opportunities to upgrade their skills in what is an extremely dynamic curriculum area. Professional Development programs combined with recognition for further study are key factors in improving the quality of mathematics and science education.

Further, that only by improving the perceived view of mathematics and science education in the general community, keeping people in the profession and increasing the pool available, is there any chance of being able to meet the demands for maths and science teachers in the mid 1990's that increased enrolments and participation will create.

5.2 Teachers' Views

Teachers' views were sought at the annual conferences run by Science Teachers' Association of Victoria and the Mathematical Association of Victoria in December, 1986. Further information was supplied by officers of both associations and the State Computer Centre.

The overwhelming evidence from the Science Teachers' and Mathematical Associations' data and consultations, is that mathematics and science teachers are concerned about their profession. They feel that their preservice education no longer meets their needs and that they have had little opportunity for quality inservice since. They are aware of current curriculum issues and recognise them as important. However, they feel they need support to put it all into practice in their schools. They are concerned about the image of mathematics and science in schools and within the wider community, and the effect that this in turn has on students' perceptions of mathematics and science.

There are concerns amongst mathematics and science teachers about the public perception of their profession generally and mathematics and science in particular. It is probably more important to deal with these perceptions and their ultimate implications for mathematics and science schooling generally, rather than implement a scheme of additional remuneration for these teachers, and for other incentives to be explored.

Whilst the Working Group does not advocate differential salary scales for mathematics and science teachers, it does consider that preferential treatment in professional development may need to be provided for these teachers. Professional Development could be linked to an improved career structure and promotional prospects.

5.3 Preservice Teacher Education

Teachers' comments tend to indicate that concerns relating to preservice Teacher Education appear to be based around content amongst primary teachers and based around methodology amongst post-primary teachers.

5.3.1 Preservice Teacher Education and Primary Teachers

The Working Group believes that students' attitudes to mathematics and science are influenced throughout schooling and that it is therefore important that primary teachers be well prepared in both of these areas.

There has been criticism of the lack of specific training in mathematics and science in preservice education for primary teachers. The resultant lack of knowledge and understanding in mathematics and science amongst primary teachers influences the emphasis on these areas in the primary curriculum and can affect students' attitudes. It might be necessary to establish pre-requisites in both areas for entry into primary teaching.

A possible alternative is for more mathematics and science to be a compulsory part of preservice courses. There are models for both approaches in mathematics. Canberra College of Advanced Education has introduced pre-requisites and the revised four year B.Ed. at the University of Tasmania has 140 contact hours in mathematics education.

The major study into primary teachers' mathematics and science education, Primary Concerns, (Appendix 5) contains a wealth of information and practical recommendations for improvement of mathematics and science in primary teacher education. There are few indications that it is being fully implemented. (Refer R 6)

The Working Group recognises that the quality of mathematics and science teaching in primary schools is not just dependent on teachers' preservice education. As identified in Primary Concerns, it is equally important that primary schools develop a coherent mathematics and science curriculum in which beginning teachers can function and become confident and competent in these subjects. (Refer S 2, Appendix 5)

The Working Group believes that, in the short term, strategies should be investigated for giving preferential employment to primary teachers with significant mathematics or science components within their studies. However, it is important that primary students have a good introduction to mathematics and science, and the Working Group believes that all primary teachers should be encouraged to study in these areas.

5.3.2 Preservice Teacher Education and Post-primary Teachers

Major criticisms of post-primary preservice teacher education relate much more to methodologies. Their personal learning experience is often very much at odds with what they are now expected to do as teachers. Yet this aspect receives little treatment in some tertiary institutions.

The Working Group believes that there is a need for some constructive cross-sectoral debate about preservice education in the area of mathematics and science education. (refer R 9)

Some tertiary institutions have proposed specific training and retraining courses and the Working Group considers these could form the basis for initial discussion between the Ministry of Education and the tertiary institutions in this area.

Further, the Working Group believes there is a clear need to involve those teachers who are recognised leaders in mathematics and science education more positively in preservice education.

While a mechanism for this to occur is not clear at this stage, cross-sectoral debate is needed to examine what is feasible.

5.4 Subject Tags

In relation to both preservice and inservice courses, there is a need to review the requirements for subject tags.

It has been suggested to the Working Group that the introduction of mathematics and science tags into all primary schools, with appropriate qualifications, could considerably enhance the status of these areas and offer encouragement to primary teachers to complete further studies to meet the tag requirements. Teachers in these tagged positions would operate as mathematics and science coordinators and provide guidance and support to other generalist classroom teachers. It is already possible to provide for tagged positions in mathematics and science, but no particular qualifications are currently required and they are restricted to Bands 1 and 2 positions.

The Working Group is aware of the special difficulties of isolated and small schools which may be further disadvantaged by the introduction of these tagged positions in bigger schools. It believes these difficulties could be overcome by the provision of extra shared specialists in mathematics and science or by some other form of preferential treatment through School Support Centres.

In the post-primary area, the current tag requirements do not necessarily take account of studies that may in fact be more relevant to current curriculum. The Working Group is aware that this is already being discussed in the science area.

It is also apparent that there are many teachers without sufficient content studies to teach senior students but who have adequate background for junior classes. Many of these teachers are already teaching without an appropriate methods course. It is therefore suggested that the introduction of junior tags be investigated. (refer R 12)

5.5 Career Paths

It is important that subject coordination and leadership roles within schools should be encouraged and rewarded. The Working Group recognises an obvious need for people with post graduate qualifications in mathematics and science education to assume leadership roles. However, teachers who have undertaken PG1

courses do not necessarily receive recognition for having undertaken further study.

The Working Group is aware that beginning teachers with additional qualifications start at a higher level. Similarly, beginning teachers in technical schools receive credit to a maximum of three subdivisions for relevant industrial experience. However, irrespective of whether they are four-year trained or have additional qualifications or industry experience, none can pass sub-division 14 without promotion or special allowances, (refer R 3).

Promotion is usually associated with an increase in administrative duties. The creation of levels above Sub-division 14 for teachers with additional qualifications would enhance the career path for classroom teachers concerned with curriculum development rather than administration. These additional levels would also recognise the value of further study undertaken by teachers. Discussions concerning any proposed new career paths for teachers are highly sensitive and will obviously need to be negotiated between teacher unions and industrial relations representatives.

5.6 Professional Development

The Working Group considers that all long term professional development should be accredited. This accreditation could take the form of a certificate or as a credit towards a post graduate qualification.

The models generally proposed for professional development programs are those based on the spaced learning such as the Early Literacy Inservice Course (ELIC). Some ELIC type courses are already being developed in the mathematics and science area. A number of projects already operating have the potential to supply both the personnel and the support materials for a range of professional development activities.

5.6.1 Existing Projects

Many of the existing projects, such as the Girls and Mathematics and Science Teaching Project of National Significance, the Mathematics Curriculum and Teaching Project and the Basic Learning in Primary Schools project, have funding until the end of 1987.

However, these projects are to be brought together in a co-ordinated program of mathematics and science inservice in 1988. This initiative is part of the Government's

economic strategy, proposed in Victoria: the Next Decade and planning is well advanced. The Working Group supports this co-ordinated approach to professional development in mathematics and science.

It believes this initiative should be supported by all concerned about improving mathematics and science education and that it also provides an avenue for vastly improving the quality of curriculum leadership in schools. However, the Working Group believes that it must be supported by an appropriate number of mathematics and science consultants. (Refer R 13 and R 14)

5.6.2 Industry and Other Experience

The Working Group believes that further opportunities should be developed for teachers to gain industrial experience. Some innovative programs have been developed interstate and overseas and the Working Group on Education for Science and Technology has investigated possible strategies.

6.0 STRATEGIES FOR INCREASING THE SUPPLY OF MATHEMATICS AND SCIENCE TEACHERS

6.1 Introduction

Although impeded by lack of some crucial data the Working Group's investigation revealed that a shortage of adequately trained mathematics and science teachers exists, particularly in the physical sciences. This shortage however is not experienced by all schools across the state, but concentrated in specific geographical locations, such as the western suburbs of Melbourne and many country centres.

As part of the Victorian Government's economic strategy a number of initiatives, outlined in Victoria: The Next Decade are to be implemented to increase the supply of qualified mathematics and science teachers. The Working Group on the Quality and Quantity of Mathematics and Science teachers endorses these initiatives and recommends that they be extended.

The following strategies should be considered in conjunction with the broader recommendations of the Working Group on Education for Science and Technology.

6.2 Ensuring An Adequate Data Base for Labour Force Planning

Whilst the Working Group acknowledges the difficulties associated with labour market predictions, it considers that a coordinated approach to identifying the future supply and demand for teaching personnel is essential. To facilitate this coordination across the Ministry a fully articulated data base is required. Therefore it is recommended:

R 1 that a reliable data base be established to identify serious shortfalls in the number of qualified teaching personnel within specific subject areas, such as mathematics and science. Further, that the data base be used as a framework for future planning in the supply of and demand for teaching personnel, and for assisting establishing the retraining needs within the existing teaching force.

6.3 Attracting Mathematics and Science Graduates into the Teaching Profession

The demand for mathematics and science graduates in other professions is increasing, particularly for industry research and development (refer to report of the Working Group on Education for Science and Technology). Industry positions can often offer greater

financial reward and greater promotional prospects. This is particularly so for graduates who qualify for admission to honours courses. While it may not be possible to match the salaries offered in industry, other incentives may encourage graduates into teaching and these should be explored.

The trend away from teaching in mathematics and science is shown in the enrolment figures collected from major tertiary institutions. At the same time an analysis of the cessation rate of mathematics and science teachers indicates that they are resigning in greater numbers than other subject areas, especially amongst those taking up employment elsewhere. These teachers are invariably in the assistant class category, often with many years of teaching. Little is done to encourage them to return to teaching at a later stage although many would have obtained additional, and valuable expertise.

The Working Group considers that new graduates need to be encouraged to enter teaching as a career, students at school need to be encouraged to consider concurrent courses and existing teachers who are not currently teaching should be encouraged to return.

The career structure available to teachers generally, and mathematics and science teachers specifically needs to be examined. The lack of flexibility and promotional opportunities within the present career structure for teachers is considered to be a major reason for mathematics and science teachers resigning from the teaching force in increasing numbers. It may also act as a disincentive for new graduates choosing teaching careers.

The Working Group therefore proposes:

R 2 that mathematics, physical science and computer science graduates be offered studentships to enter teacher training.

R 3 that flexible career paths for potential mathematics and science teachers be developed and specific incentives explored to encourage experiences teachers to pursue roles as curriculum leaders in mathematics and science.

R 4 that the credit system for industry experience established for teachers entering Technical schools at assistant class level be investigated for all post-primary teachers. Further, that ways of incorporating industry experience into teachers career paths be explored. (Refer 5.4 and R 10)

6.4 Improving the Preservice and Professional Development opportunities for Primary and Post Primary Mathematics and Science Teachers

Those teachers who are currently qualified to teach mathematics and science should be encouraged to remain within the teaching service. Similarly, teachers with little or no background in mathematics and science should be encouraged to retrain. Strategies which improve the professional development and retraining opportunities for teachers should be developed to enhance the future supply of mathematics and science teachers.

Primary Teachers:

The Working Group consider that the serious lack of mathematics and science training provided to primary teachers should be addressed. It therefore recommends the following strategies:

R 5 that preferential employment in primary schools be offered to primary teachers with significant mathematics or science components within their preservice education course.

R 6 that the implementation of the recommendations in the report Primary Concerns (1985) be monitored with regard to preservice programs for primary teachers. (Appendix 5)

R 7 that subject tags for mathematics and science be introduced and encouraged for all primary schools. (Refer 5.3)

R 8 that the retraining of unemployed primary teachers as post-primary junior mathematics and science teachers be continued.

Post-Primary Teachers:

The Working Group consider the preservice courses and professional development opportunities for post-primary teachers in mathematics and science need specific attention. It has identified a need to coordinate preservice education across the tertiary and post compulsory sectors to meet the Ministry's requirements.

The Working Group recognised the dynamic nature of the mathematics and science curriculum which is subject to considerable change in both content and methodology. It is considered necessary for post-primary teachers to be encouraged to undertake

further studies and appropriate courses must be available.

The Working Group therefore recommends:

R 9 that consultations be held with the Victorian Post Secondary Education Commission on:

(i) improving the preservice education of post-primary teachers through examination of course methods, practicum and duration and;

(ii) establishing and extending certificate and post-graduate courses that meet the needs of experienced teachers undergoing further training.

R 10 that as a long term objective teachers should be provided with opportunities to gain industrial experience as part of an overall professional development program.

R 11 that study leave awards be available to teachers who undertake retraining in areas of shortage, especially where a significant practical component is involved. (Refer 2.3.2)

R 12 that a review of subject tag requirements for post-primary mathematics and science positions be undertaken with a view to establishing tags appropriate to current curriculum and introducing a junior mathematics tag.

Professional Development:

The Working Group considers it essential that a professional development program support mathematics and science teachers in schools. In particular, it believes that mathematics and science coordinators need to upgrade their skills and knowledge. The provision of an appropriate number of mathematics and science consultants is needed to facilitate the program.

The Working Group therefore recommends:

R 13 that programs be developed to assist mathematics and science coordinators to upgrade their skills and knowledge in order to provide stronger leadership in mathematics and science departments in post-primary and primary schools.

R 14 that an appropriate number of mathematics and science consultants positions be established to facilitiate an adequate professional development program in mathematics and science.

6.5 Ensuring an adequate future supply of Qualified Mathematics and Science Teachers

The Working Group considers that the Ministry must ensure a constant supply of qualified mathematics and science teachers for all schools in the future. The future increase in participation rates expected with the introduction of the VCE and Blackburn initiatives, will in turn demand additional teachers, in Mathematics and Science. The supply of future mathematics and science teachers needs to improve and is unlikely to occur through concurrent or Dip.Ed. teacher training courses in the short term. The following strategies are recommended to increase the supply of mathematics and science teachers in the short and long term:

R 15 that graduates from industry be trained for teaching through the expansion of courses such as those at Hawthorn Institute of Education. Further, the implementation of R 4 be seen as a mechanism for attracting both industry graduates to teaching, and teachers in industry back into teaching.

R 16 that the introduction of part-time appointments, especially for women who provide valuable role models in mathematics and science, be investigated and that particular attention be given to the possibility of job sharing.

R 17 that a study be undertaken into the potential pool of non-English speaking background teachers and their training needs as potential mathematics and science teachers.

7.0 CONCLUSION

The Working Group considers the adequate supply of appropriately qualified mathematics and science teachers for Victorian Schools is critically important for the eventual success of the economic strategy and for ensuring students are well prepared to participate fully in the technological society. The latest economic strategy statement, Victoria: The Next Decade reflects the government's recognition of the importance of education for its long term plan. The specific initiatives within this statement relating to retraining and professional development address the concerns of the Working Group. The Ministry is well placed to build on these initiatives which will enhance the provision of mathematics and science teachers in the future.

As has been stated throughout the body of this report there is a severe lack of precise data on the current number of qualified mathematics and science teachers within the Ministry. The Working Group consider the recommendation to establish a comprehensive data base is vital for both long term planning and policy development across the Ministry as well as a mechanism for ensuring appropriate resource distribution for all schools.

The Working Group consider its recommendations should be implemented as efficiently and effectively as possible with a coordinated approach. It therefore proposes that the responsibility for monitoring and coordinating the implementation should be the role of the proposed Ministerial Advisory Group on Science and Technology. The implementation of all policy recommendations relating to mathematics, science and technology could be carried out by the Ministry's Science and Technology Facility proposed by the Working Group on Education for Science and Technology.

ENROLMENTS IN POST-PRIMARY DIP. ED. MATHEMATICS AND SCIENCE METHODS FOR THE PERIOD 1984 -1987 AS AT MARCH 31ST

a. MONASH UNIVERSITY

	1984	1985 (11)	1986	1987
(i) Total Dip.Ed. Enrolments (for all methods)	348	334 (17)*	307	282
Method:				
Maths	64	50 (15)*	59	41
Double Maths	34	12	20	15
Computer Science	7	4	4	3
General Science	44	47	39	28
Biology	37	50 (3)*	44	36
Chemistry	24	28 (4)*	23	17
Physics	14	11 (12)*	11	7
TOTAL	224	202	200	147

b. MELBOURNE UNIVERSITY

	1984	1985	1986	1987
(i) Total Dip.Ed. Enrolments	n/a	n/a	388	350
Method:				
Maths	n/a	n/a	50	40
Computer Science	n/a	n/a	6	6
General Science	n/a	n/a	54	48
Biology	n/a	n/a	53	39
Chemistry	n/a	n/a	36	21
Physics	n/a	n/a	14	14
TOTAL			215	168

c. LA TROBE UNIVERSITY

	1984	1985	1986	1987
(i) Total Dip. Ed Enrolments	235	252	262	246
Method:				
Double Maths	8	10	6	8
Maths	25	25	28	10
Computer Science	5	3	5	5
Biology	24	17	23	14
Chemistry	24	21	21	16
Physics	4	8	8	5
TOTAL	90	76	91	58

d. VICTORIA C.A.E.
(Rusden Campus)

	1984	1985	1986	1987
(i) Total Dip. Ed. Enrolments	130	130	130	125
Method:				
Double Maths	n/a	3	3	-
Maths	n/a	11	18	16
Science	n/a	32	41	25
Chemistry	n/a	12	15	12
Physics	n/a	1	3	6
Biology	n/a	15	20	14
Earth Science	n/a	4	8	3
TOTAL		78	108	76

e. MELBOURNE C.A.E.

	1984 (iii)	1985	1986	1987
(i) Total Dip.Ed. Enrolments	140.5	148	133.5	138.5
Method:				
Junior Maths	42 (30)	45	29	19
Senior Maths	23 (8)	20	16	10
Computer Science	9 (1)	0	0	0
Junior Science	28 (26)	47	36	26
Biology	4	6	4	8
Chemistry	10 (12)	21	14	10
Physics	15 (10)	11	4	5
TOTAL	131	150	103	78

Note: (i) The total Dip. Ed. Enrolments for the methods are also decreasing, as the above figures show, as a direct consequence of the decline in the number of students undertaking mathematics and science methods.

(ii) * Numbers in brackets for 1985 were a mid-year intake.
(iii) * Numbers in brackets for 1984 were a mid-year intake.

Source: Statistics Sections in each tertiary institution.

ENROLMENTS IN THE FOURTH YEAR OF THE FOUR YEAR CONCURRENT COURSES, 1984-1987 AS AT MARCH 31ST, 1987

a. MELBOURNE C.A.E.

Method:	1984	1985	1986	1987
Junior Maths	44	49	66	61
Senior Maths	22	21	31	26
Computer Science	1	0	0	10
Junior Science	73	89	115	85
Biology	33	46	52	32
Chemistry	16	19	38	19
Physics	3	6	8	13
TOTAL	192	230	310	246

b. VICTORIA COLLEGE (Rusden Campus)

Method:	1984	1985	1986	1987
Double Maths	n/a	12	25	16
Maths	n/a	30	26	38
Biology	n/a	47	59	55
Science	n/a	56	77	80
Chemistry	n/a	16	8	23
Physics	n/a	16	8	9
Environmental Science	n/a	14	7	3
Earth Science	n/a	14	18	7
TOTAL		205	228	231

STAV SCIENCE SURVEY — 1985

Peter Martin Executive Officer — STAV

For some years prior to 1984, the Research and Development Branch of the Education Department, conducted an annual science curriculum and resources survey, embracing all Victorian High Schools. It provided information on the overall number of Science teachers, the time allocated to science in schools and the curriculum resources utilized at Years 7 to 10, as well as information on student numbers in science classes. In 1984, the survey was discontinued, due to other demands on Science Centre personnel.

In 1985, STAV Council, aware that the Departmental survey gave a rare opportunity to assess the state of science teaching in Victoria, commissioned a survey of all of STAV's member schools. The survey was to cover much of the ground covered by the earlier Departmental survey, to enable trends to be identified, but also to collect data from State Technical, Catholic, and Independent Schools. It also addressed areas of particular concern to STAV, such as time release for in-service, and time and monetary allowances for science co-ordinators. A total of 430 questionnaires were distributed with 172 schools replying. Though not a random sample of schools, the large number of schools in the sample gives confidence to the assertion that the survey results are representative of Victorian schools in general.

The Survey results have been grouped into 5 areas, (1) Time Allocation to Science, (2) Monies Available to Science Faculties, (3) Curriculum Materials used in Junior Science, (4) Science Co-ordinators Conditions and (5) Gender Biases in Science.

1. TIME ALLOCATION TO SCIENCE

Schools were asked to report the number of minutes allocated to Science at each year level.

Table 1 records Year 12 data, Tabel 2 records Year 11 data, and Table 3 records Year 7—10 data.

Table 4 compares data from the 1980—82 departmental surveys of High Schools with the 1985 data from High Schools.

TABLE 1

YEAR 12 SUBJECTS — MINUTES PER WEEK

	STATE HIGH SCHOOLS	CATHOLIC SCHOOLS	INDEP SCHOOLS
PHYSICS	249 MIN (N = 92)	242.5 MIN (N = 11)	248 MIN (N = 22)
CHEMISTRY	248 MIN (N = 95)	244 MIN (N = 10)	248 MIN (N = 22)
BIOLOGY	247 MIN (N = 96)	246 MIN (N = 19)	248 MIN (N = 22)

*There was insufficient data re HSC and TOP Classes in Technical Schools, for comparative purposes.

TABLE 2
YEAR 11 SUBJECTS — MINUTES PER WEEK

	STATE HIGH SCHOOLS	STATE TECH SCHOOLS	CATHOLIC SCHOOLS	INDEP. SCHOOLS
PHYSICS	233 MIN (N =98)	235 MIN (N = 13)	226 MIN (N = 13)	218 MIN (N = 13)
CHEMISTRY	233 MIN (N = 98)	235 MIN (N = 13)	223 MIN (N = 21)	218 MIN (N = 13)
BIOLOGY	232 MIN (N = 98)	233 MIN (N = 8)	225 MIN (N = 21)	218 MIN (N = 23)
GENERAL SCIENCE	225 MIN (N = 10)	210 MIN (N = 14)	*	*
ENVIRON. SCIENCE	232 MIN (N = 7)			

*Indicates insufficient data.

TABLE 3
MINUTES PER SCIENCE CLASS PER WEEK

	STATE HIGH SCHOOLS	STATE TECH SCHOOLS	CATHOLIC SCHOOLS	INDEP. SCHOOLS
YEAR 7	146.2 MIN (N =91)	143.2 MIN (N = 18)	153.8 MIN (N = 20)	160.7 MIN (N = 24)
YEAR 8	152.3 MIN (N = 89)	155.0 MIN (N = 16)	158.0 MIN (N = 20)	158.6 MIN (N = 24)
YEAR 9	153.2 MIN (N = 91)	152.1 MIN (N = 14)	151.3 MIN (N = 20)	164.0 MIN (N = 25)
YEAR 10	161.6 MIN (N = 90)	171.1 MIN (N = 14)	168.5 MIN (N = 20)	175.3 MIN)N = 23)

TABLE 4
MINUTES OF SCIENCE PER WEEK IN HIGH SCHOOLS 1980—85

YEAR LEVEL	YEAR	MINS/WEEK
7	1980	170
	1981	153
	1982	151
	1985	146
8	1980	159
	1981	156
	1982	153
	1985	152
9	1980	150
	1981	162
	1982	161
	1985	153
10	1980	147
	1981	170
	1982	175
	1985	162

The Tables indicate that the amount of class time devoted to Science at Year 7 has decreased significantly since 1980, and the figures at Year 10 show a disturbing downturn since 1981. It is also of interest that at independent schools, about 10% more time is spent on Junior Science than in State High Schools.

These figures are well below the A.S.T.A. recommendation contained in the 'ASTA Policy on Science Curriculum' which was included in the November 1980 ASTA. That policy recommended a minimum of 3 hours per week study of science for all students in Years 7—10.

While figures for Year 12 Science subjects were all in excess of 240 minutes per week, in many schools, 200 minutes or less was spent on each Year 11 subject.

2. MONIES AVAILABLE TO SCIENCE FACULTIES

Government schools have access to credit funds on the Government Stories Branch (S.E.A.R.C.H.E.S.) as well as monies from subject levies (student allowances) and School Council grants. Sources of funds for non-government schools vary from school to school. Table 5 lists the funds available per head of student population for the different types of schools surveyed.

TABLE 5
FUNDS AVAILABLE TO SCIENCE FACULTIES PER STUDENT (AVERAGE)

A. HIGH SCHOOLS		
S.E.A.R.C.H.E.S.	$2.62	(N = 88)
OTHER SOURCES	$6.67	(N = 71)
TOTAL	$9.49	
B. TECHNICAL SCHOOLS		
S.E.A.R.C.H.E.S.	insufficient data	
OTHER SOURCES	$10.44	(N = 12)
C. INDEPENDENT NON-CATHOLIC SCHOOLS		
TOTAL FUNDS	$19.04	(N = 11)
D. CATHOLIC SCHOOLS		
TOTAL FUNDS	$15.09	(N = 11)

*Some independent schools reported that there appeared to be no limit on funding, provided expenses were "reasonable".

The 1982 Departmental survey reports that the average SEARCHES allocation per head in high schools was $2.69. Thus, there has been very little change in 3 years!

3. CURRICULUM MATERIALS USED IN JUNIOR SCIENCE

YEAR 7 CURRICULUM MATERIALS

162 schools reported on their Year 7 Curriculum Materials. Some used only school based materials, some used one student text, while others used a variety of materials. The frequency with which each type of material v used is recorded in Table 6.

TABLE 6

CURRICULUM MATERIAL	NO. N=162	PERCENT. %	1982 %
A.S.E.P.	108	67	91
J.S.S.P.	38	23	57
World of Science (Learmonth et al)	52	32	—
Secondary Science (Wilkinson)	32	20	—
Exploring Science (Stannard)	28	17	—
Science for Secondary Schools (Heading et al)	20	12	38
Concepts of Science (Cull & Drake)	15	9	—
Fundamental Science (Anderton et al)	10	6	—
In Search of Science (Russell et al)	8	5	22
Towards Tomorrow (Criddle et al)	7	4	—
The Sense of Science (Grossbard et al)	6	4	—
Working with Science (Comino et al)	6	4	—
Active Science (Fox et al)	5		
Science to 16	3		
Science for the 70's	3		
Prerequistie Laboratory Skills	3		

In addition, another 22 texts or units of work were used by one or two schools. The curriculum patterns were very similar a Years 8 & 9.

The drop in support for ASEP and particularly JSSP over the past 3 years is self evident, while several new texts have gained considerable usage.

YEAR 10 CURRICULUM MATERIALS

165 Schools reported on their Year 10 Curriculum Materials. Many schools reported that they used schoo based units, and then listed up to 15 resources that wer used at Year 10. To simplify the collating of informatio materials were recorded in Table 7 only if they wer either a text or were in the FOUR major resources use by the school at that level.

TABLE 7

MATERIAL	SCHOOLS (N = 165)	% OF SCHOOLS
ASEP	56	34
WORLD OF SCIENCE (Learmonth)	38	23
THE SCIENCES (Olsen et al)	23	14
SECONDARY SCIENCE (Wilkinson)	17	10
EXPLORING SCIENCE (Stannard)	15	9
JSSP	12	7
SCIENCE FOR SECONDARY SCHOOLS (Heading et al)	11	7
CONCEPTS OF SCIENCE (Cull & Drake)	8	5

Many other resources were used by 5 or less schools.

Many schools at both Year 7 and Year 10 levels failed to indicate whether a resource was used as a text or as a class set. The 1986 survey will be worded so as to distinguish between the two.

4. SCIENCE CO-ORDINATORS CONDITIONS

Table 8 details the average time allowance awarded to co-ordinators in the different systems. Table 9 reports on the percentages of co-ordinators reviewing different levels of funding.

TABLE 8

TIME ALLOWANCE (AVERAGE)

HIGH SCHOOLS	2.54 PERIODS	(N=76)
TECH. SCHOOLS	1.97 PERIODS	(N=16)
IND. SCHOOLS	1.89 PERIODS	(N=21)
CATH. SCHOOLS	2.58 PERIODS	(N=23)

A clear majority of co-ordinators received an allowance in excess of $2,000; however it is disturbing to observe that some co-ordinators receive no allowance. Similarly, a few co-ordinators reported that they received no time allowance at all.

TABLE 9

Percentages of co-ordinators received various allowances.

	HIGH SCHOOLS	TECH SCHOOLS	INDEP. SCHOOLS	CATHOLIC SCHOOLS
ALLOWANCE				
Senior Teacher ($2500+)	5	6	5	—
S.D.A. (= $2000)	66	57	24	13
½ S.D.A. ($1000—$1600)	1	—	33	9
$500 — $1000	1	—	27	21
NO ALLOWANCE	27	37	11	57
	(N=76)	(N=16)	(N=21)	(N=23)

5. GENDER BIASES IN SCIENCE

Tables 10 and 11 list the proportions of males and females teaching at least one science class per week, and the proportions of males and females acting as science co-ordinators.

TABLE 10

SEX RATIO OF ALL TEACHERS TEACHING SOME SCIENCE

	MALE	FEMALE	TOTAL	%FEMALE
HIGH SCHOOLS (N = 104)	729	347	1,076	32%
TECH. SCHOOLS (N = 14)	120	31	151	21%
POST. PRIMARY (N = 4)	16	10	26	38%
INDEPENDENT (N = 25)	83	87	170	51%
CATHOLIC SCH. (N = 24)	112	91	203	48%
TOTALS	1,560	566	1,626	35%

TABLE 11

SEX RATIOS OF SCIENCE CO-ORDINATORS

	MALE	FEMALE	TOTAL	%FEMALE
HIGH SCHOOLS (N = 104)	83	20	103	19%
TECH. SCHOOLS (N = 14)	12	2	14	14%
POST. PRIMARY (N = 4)	4	0	4	—
INDEPENDENT (N = 25)	16	9	25	36%
CATHOLIC SCH. (N = 24)	17	7	24	29%
TOTALS	132	38	170	22%

The significant differences between the relative ratios in the two tables can be interpreted in a variety of ways — e.g. are woman less likely to offer themselves for co-ordination positions; are appointments subject to a gender bias, and so on.

CONCLUSIONS

The survey results raise some important issues for several faculties to consider. Matters such as declining class time in junior science, less class time at Year 11 than in Year 12, the lack of monies available to many science faculties, the number of science co-ordinators without time and/or monetary allowances, and the relative paucity of female co-ordinators are all matters of concern. Science faculties may be interested in using the figures in this document to argue for different teaching conditions in their schools.

A final set of statistics from the survey may be of interest. Table 12 lists the number of in-service days available per faculty member for science teachers. Co-ordinators who are having difficulty obtaining the release of a faculty member to attend an in-service may find the following data useful.

TABLE 12

IN-SERVICE DAYS PER FACULTY MEMBER

HIGH SCHOOLS	1.04 DAYS	(N=85)
TECH. SCHOOLS	0.39 DAYS	(N=13)
IND. SCHOOLS	0.98 DAYS	(N=22)
CATH. SCHOOLS	0.89 DAYS	(N=19)

STAV thanks the co-ordinators who returned the 1985 survey for their assistance, and thanks the Ministry of Education's Science Centre for making available statistics from the document 'Science Curriculum and Resources Surveys 1980—82', by S.K. SHARMA.

ANALYSIS OF 1986 PRIMARY SCIENCE SURVEY

The Primary Science Survey was planned and carried out by the Primary Science Task Force in October, 1986, in an attempt to ascertain the current state of science teaching and resources in Victorian Primary schools.

Of the 200 schools which were surveyed, 126 replied in time to be included in this analysis. The schools were selected randomly from a list of schools with Band 3 or 4 teacher class positions, giving the sample a bias towards larger primary schools. Of the schools replying, 76% had an enrolment of 150 or more, and only two schools had less than 50 pupils. Country schools provided over 45% of the replies, so the sample provided a reasonable selection of both metropolitan and country schools. In a letter to the principal which accompanied the survey, we requested that the survey go to staff members who did not have a particular interest in science, as we were interested in the views of the average primary teacher.

SCIENCE RESOURCES

Predictably, responses to this section of the survey showed that science equipment in many primary schools is in a poor state. When asked about methods of storage, 25% of schools replied that there was not enough to worry about and 41% replied that there was no one in charge of the equipment at their schools. Of the staff responsible for science equipment, only 12% were senior staff (Band 3 or above).

Of the curriculum documents present in schools, by far the most common were Science in the Primary School and Springboards-Ideas in Science. Science in Action, New Zealand Primary Science Units and Bendigo Teacher's College Guides were also popular and individual schools also named a wide selection of alternative texts. Television broadcasts were used by 32% of schools, the most popular being Infinity Limited (12%), Hunter (10%) and Lower Primary Science (5%).

In the section on facilities, only 16% of schools had a "science room", 55% had no "wet" areas, 62% had no sources of heat or power for experiments and 70% of schools surveyed had inadequate equipment.

The section on science teaching revealed that a wide variety of teaching methods is employed with no particular trend evident other than team teaching and the use of visiting speakers does not appear popular.

SCIENCE IN THE CURRICULUM

This section of the questionaire provided some interesting responses and showed science occupies a very low priority in many primary schools. While 65% of schools had science coordinators (40 males, 43 females), only 17 of these coordinators received any special time release to carry out their duties. Even some of those who said they did receive time release seemed to think that we were asking if they received normal A.P.T. release and therefore the number receiving any extra time release may have been even less.

Only 26% of schools surveyed had a science curriculum committee and even their effectiveness could be questioned on the basis that only 11 of these committees had one or more meetings a month. The majority of of schools (75%) claimed to have a writtten science policy, however in many schools the policy is obviously not taken seriously as only 62% of schools actually followed a science program. The majority of those who did follow a program based it on SIPS, Springboards or were school based. A small number of initiatives were outlined, often based around Science-in-Schools Week, Arbor Week or some similar science promotion.

In the section regarding time spent on science in the classroom, eighteen schools (14%) spent less than 30 minutes on science per week, while only 28% of surveyed schools spent more than an hour. While this may be a difficult statistic to interpret in these days of integrated curriculum, the figures quoted still demostrate the low priority that science holds in the curriculum. Perhaps a more effective measure of the place of science in the curriculum is the amount of money spent on curriculum materials per student. In this section, 51 schools replied that they spend less than $1.00 per student annually, while 19 schools left the section blank implying that more than half of the schools surveyed spend less than 2 cents per student per week on science equipment. Although primary science activities do not need to be centred around expensive equipment, plasticene and balls of string cost more than 2 cents a week!!!

In the section regarding the importance of science in the curriculum, 10 schools regarded the teaching of science as not important at all, while the great majority of schools (80%) regarded science as being "moderately" important.Only 9 schools rated science as being extremely important in the primary school. With regard to the integration of science with the rest of the curriculum, again the majority of schools stated that science was "moderately" integrated into the total program.

Specialist primary science teachers are in short supply-only 11 (8 males and 3 females) in 126 schools and most of them are only part-time. With regard to science qualifications, 54% of primary teachers had studied science as either a major or sub-major in their teacher training. On the surface then, primary teachers may appear to have a reasonable background in science. However if we analyse the responses a little further, only 14% of those teachers had studied any science subjects at Year 12, and only 4% at University level, so at some early stage in their secondary schooling, most Primary teachers had opted out of science. In the section listing the areas of science curriculum in which teachers need assistance, nearly all areas listed were widely selected, the areas causing most concern being Integrating Science into the Curriculum (44%) and Management and Storage of Science Equipment (24%). Despite requests for assistance in these areas, 80% of schools had not had a visit from a science consultant for at least 2 years, and 55% of schools could not recall the last visit! This situation will only worsen in 1987 as further cuts to regional school support staff have made science consultants a rare luxury.

Our thanks for the above survey go to the schools and teachers who gave up their precious time to fill in yet another survey, and to the members of the 1986 Primary Science Task Force who spent many hours putting the survey together and sending it to schools and collating results. Special thanks to Nigel Liggins, who provided the numerical analysis of the survey.

SUMMARY: PRIMARY SCIENCE SURVEY 1986

The number of replies processed: 126

Metro 69
Country 57

60 Band one
36 Band two
15 Band three
3 Band four
12 Other persons (replied on behalf of the school)

School enrolments varied from:

0 - 50	2 schools
51 - 100	8 schools
101 - 150	16 schools
151 - 200	18 schools
201 - 300	40 schools
300+	38 schools

with 4 schools not indcating enrolment figures.

A. Science Resources

1. To store the resources:
   31 responded that there was not enough to worry about
   23 used classroom storage
   84 used some form of central storage
   11 used a unit box system.
   (Note, figures don't add to 126 as some recorded more than one method of storage)

2. In charge of science equipment varied with:
   2 schools have a committee
   52 having no one in charge and
   72 schools having an individual responsible for maintaining the equipment.

3. Of the 72 in charge, 64 are teaching staff members, with:
   Band 1 teachers - 28
   2 teachers - 26
   3 teachers - 13
   4 teachers - 2

4. Only 12 schools have a written policy on the borrowing and maintenance of equipment and 12 schools use student monitors.

5. There is a wide range of science documents available in schools with the following breakdown:
   S.I.P.
   Springboards
   N.Z. Units
   Science in Action

Other resources used were:

1. Cheryl Dales material (Coburg Campus)
2. Science 5/13 (9 schools)
3. Beginning Science
4. Following On
5. Yarrawonga TPS
6. Gould League material (3 schools)
7. Warrandyte Environ. Ed.
8. (S.T.E.M.)?
9. Solar Energy kit (3 schools)
10. Bendigo College materials (8 schools)
11. Addision Wesley materials
12. Environment starters
13. Animal Studies in Schools
14. Exploring Units 1-3
15. Burwood College materials (2 schools)
16. Scince Concepts in Action (2 schools)
17. McMillan starters.
18. Nuffield 5/13.
19. Fun with Science.
20. Lynn Wallace, Dand/Lilydale Insp. (5 schools)
21. "We Do" series.
22. School developed (3 schools)
23. Science resources (?)

T.V. broadcasts are reasonably popular with 40 schools using them and the programs viewed were:

Hunter - 13 schools
Infinity - 15 schools
Behind the News - 1 school
Lower Primary Science - 6 schools
F. Feathers - 1 school
Curiosity Show - 1 school
For the Juniors - 1 school
Why Wherefore - 1 school.

Some schools didn't list programs, others said they were not used regularly.

Of the science consultants - the visit breakdown:

Last term - 9 schools
12 months - 12 schools
2.4 years - 30 schools
Can't recall - 70 schools
Now in region 1 - (3 schools non reply)

For teaching science the facilities breakdown was as follows:

	Yes	No
Science Room	20	106
Wet Area	57	79
Display Space	63	63
Heat	76	50
Power	78	48
Adequate Equipment	38	88

(Note, when the response was on the Yes/No boundary - 1 took No as the response).

In 2 instances the science room was the Art/Craft room also.

B. Science Teaching

This question did not prove much other than team teaching is not popular, and guest speakers do not appear to be full utilised. The other responses showed some interesting ideas e.g. community projects
themes approach
individual projects
videos
report writing
use of nature walks.

Methods employed:
- Group activities
- Chalk and Talk
- Guest Speakers
- Worksheets
- Team teaching
- Assignment work
- Class discussion
- Creative Writing

C. Science in the Curriculum

A very revealing section - science basically doesn't rate!

Science coordinators can be found in 83 schools with 40 being males and 43 being females, however only 17 have any time release.

The time release varies from: 0-30 mins for 3 people, 30-60 mins for 3 persons, 60-120 mins for 4 people, 1 person has 4.3 hours/week, while 5 have flexible time allocations, 1 person did not know.

School based curriculum committees, other than general policy groups, are found in 33 schools however their function and value could be questioned. The regularity of meeting is largely random:

Frequency of meetings and terms used:
- Barely - 3 schools
- Twice a term - 2 schools
- Once a year - 2 schools
- 5/6 times a year
- Not during 1986
- When required! - 5 schools
- Monthly - 6 schools
- Bi monthly - 1 school
- Fortnightly - 3 schools
- Now and then - 2 schools

Policy has been written in a majority of schools (95) but some are very out dated and 6 respondents did not know or reply to this question.

Date of policy:	pre 1976	5
	1977-82	17
	83-86	65
currently being written		2

Of the science programs, a large number don't follow any program which is disappointing: (47)

Of the 79 which do have a program, the following responses were recorded (again more than one recorded by majority of schools):

53	follow	SIPs
4	use	N.Z. Units
29	use	Springboards
42	use	School based

other programs were based on the written documents (see earlier).

School based initiatives varied, but were seen to be used by 44 schools and included:

1. Seed lift (2 schools)
2. Science in Action
3. Development of 'Assignment Cards'
4. Introduce specialist teachers
5. Arbor week (3 schools)
6. S.I.S.W. (5 schools)
7. Animals in schools (2 schools)
8. Development of the school plantation
9. Curriculum Day devoted to science
10. Building/introduction of horticulture and hothouse (3 schools)
11. Gould League (2 schools)
12. Use of native sanctuary.

The average time spent was low considering total time for week, some said science was integrated - based on themes etc, which makes actual tally difficult however figures were:

0 - 30 mins	18	
31 - 60 mins	63	
61 - 90 mins	9	
91 - 120 mins	21	
120 mins	6	
Varies	2	
No reply	2	
1 - 3hrs/Theme	3	(2 schools short)

Tally of hours: 126 hours+ (across the 126 schools on 1hr/wk)

Money spent was very low:

$ 0 - 1	51	schools
1 - 2	26	
2 - 4	6	
7 4	5	

Other terms used:

Nil	1
As needed	4
Minimal	1
Zilch	1

The importance of science in overall curriculum as per integration:

Not	4
Moderate	105
Full	17
	126

The importance of science in curriculum:

Not	13
Moderate	100
Extremely	9
No response	4
	126

Assistance - all areas need addressing figures are:

Management	25
Storage	30
Retrieval	21
Maintenance	20
Sch. Curr. Comm.	18
Integration	56
Curriculum doc.	37
Time release	19
Course content	33

Other requests (a) Use of SIPs (!)
(b) Evaluation
(c) Use and development of kits.

Schools nominated any area; some listed all.

Specialist Science teaches are in short supply! - only 11 exist in 126 schools, 8 males and 3 females.

Of the 126 schools the majority of respondents were able to list all their staff and their qualifications. 589 was the total number of teachers, ad the highest level of qualification has been recorded:

		% using 569
Less than Yr 11	77 teachers	
Year 11 Science Subjects	79 teachers	
Year 12 Science Subjects	82 teachers	
College Sub Major	243 teachers	
College major	66 teachers	
Unit (degrees plus subjects)	22 teachers	
TPTC	3 teachers)	
B. Ed. Science Instit.	2 teachers)	20 teachers
Curriculum units?	6 teachers)	
No response	9 teachers)	

* Note some school respondents only listed themselves or just their year level teachers.

A PROJECT ON MATHEMATICS AND SCIENCE IN PRIMARY TEACHER EDUCATION

During 1984, the Centre for Program Evaluation (CPE) at Melbourne College of Advanced Education conducted a Project related to primary teacher education, with particular reference to mathematics and science. The Project was funded by the Commonwealth Tertiary Education Commission (CTEC) and the general aim was to gather and disseminate information which will help decision makers design more effective teacher education programs.

The Project was national in scope with information on current practices and procedures in primary mathematics and science being collected from individual institutions and campuses throughout Australia. Using this information as a data base two directories (one for science and one for mathematics) have been completed and published separately.

The collection of more detailed information on science and mathematics in primary teacher education was limited to Victoria. Data were collected in two major areas of concern to primary teacher educators; the nature and form of mathematics and science components within the context of total primary teacher education preservice programs, and the opinions of beginning teachers about the mathematics and science studies they undertook in their teacher education.

Six areas of concern were identified from these data. These were:

1. Beginning Teachers: Problems of Induction and their Impressions of Support From Pre-Service Courses.

2. Acquisition and Transfer of Teaching Skills and Approaches.

3. Relating and Integrating: Relationships Between Programs and Within Courses.

4. Information Sharing Between Primary Mathematics and Science Educators.

5. Structure of Programs.

6. Mathematical and Scientific Aptitudes and Attitudes.

These formed the basis for draft Project Papers and recommendations which were discussed at a conference of primary teacher educators and other parties in November 1984. Subsequently, a Main Report including Project Papers and other contributions from selected participants, was assembled. In addition, a final version of the recommendations has been developed and is outlined below.

An attempt has been made to match each recommendation to particular audiences for their consideration and action. This information is included in Table 1 of this Summary.

As noted earlier the recommendations have emerged from a study of the Victorian context. However, the Project Team is of the opinion that many of the findings and recommendations are applicable across the nation.

MAIN FINDINGS AND RECOMMENDATIONS

1. BEGINNING TEACHERS IN SCHOOLS

See Chapter 2 of the Main Report.

Beginning teachers reported different levels of school support for teaching mathematics and science. In general, Victorian beginning teachers had recourse to a policy and a program for mathematics, but it was far less likely that a science policy or program was available to them.

For mathematics, difficulties of beginning teachers were concentrated in the area of teaching and learning, while in science, difficulties were far more fundamental and based around deciding what to teach, and how to prepare resources for that teaching.

RECOMMENDATION 1.1

That curriculum programs in mathematics and science be specified in each school to the extent that beginning teachers do not have to make major decisions regarding what to teach.

Research on educational change shows that support for curriculum implementation must be school based, person centred, interactive and continuous. In addition, the existence of guidelines for mathematics and science in schools is a pre-requisite for beginning teachers to work effectively in these areas. However, teacher educators expressed the concern that continuing assistance was seldom available to schools for the development of appropriate mathematics and science curricula, and for the implementation of these curricula.

TABLE 1

Audiences for Project Recommendations

Recommendation Number	Outside Agencies	Audiences within Institutions		
		Teacher Education Institution Administration	Mathematics/ Science Departments	Other Departments or groups
1.1	Education Depts. Schools			
1.2	Education Depts. Schools			
1.3	Education Depts. Schools		Science Depts.	
1.4	Education Depts. Schools			
1.5	Education Depts. Schools		Maths/Science admin and teaching staff	
2.1		Course Committees	Maths/Science admin and teaching staff	Departments concerned with "method" areas
2.2			Maths/Science teaching staff	Teaching staff of "method" areas
2.3	Supervising teachers in schools		Maths/Science teaching staff	School Experience Departments Staff who supervise students in schools
2.4			Maths/Science teaching staff	
2.5	Training schools	Course Committees		School Experience Departments
2.6	Agencies funding research	Course Committees Research Committees		
3.1		Course Committees	Maths/Science admin and staff	Staff responsible for Child Development Studies
3.2		Course Committees	Maths/Science admin and teaching staff	School Experience Departments
3.3			Maths/Science admin and teaching staff	Teaching staff of "method" areas
3.4			Maths/Science admin and teaching staff	Other Departments in Institution
4.1		Course Committees Review Committees	Maths/Science admin	
4.2	CTEC Prof. Maths/ Science Associations			
4.3		Course Committees	Maths/Science admin and teaching staff	
4.4			Maths/Science admin and teaching staff	
5.1		Course Committees Review Committees		
5.2		Course Committees	Maths/Science admin	
6.1	Education Departments	Course Committees		
6.2			Maths/Science admin and teaching staff	
6.3			Maths/Science admin and teaching staff	
6.4			Maths/Science admin and teaching staff	

As noted in Project Paper 1, science programs in schools seem to be far less developed than mathematics programs, and there appears to be a special need for support to upgrade the status of science in schools. In some States (such as South Australia), this seems to be a priority area in the overall planning of primary education. This is not something which can be achieved in the short term. It requires a sustained systematic effort involving the support of Education Departments through policy development, provision of resources and expertise. While specific recommendations regarding the place of science in primary schools is outside the scope of this study, we believe that educational authorities should examine the extent of resources and expertise now available for science in primary schools. This should be done with a view to implementing arrangements which would lead to a long term improvement of science in primary schools.

RECOMMENDATION 1.2

That umbrella agencies (such as education departments) continue to provide system level support in terms of policy and program guidelines for mathematics and science in primary schools, and that such agencies also provide consultancy and other person intensive support to assist schools implement effective mathematics and science programs.

RECOMMENDATION 1.3

Given the current situation, we recommend

That science lecturers make clear to potential teachers the lack of resources for science in primary schools. Further, that science lecturers provide opportunities, during the course, for a consideration of ways by which beginning teachers can provide science for primary school pupils under these conditions.

Data collected in the study, combined with other research, show that in the first years in schools, many teachers find difficulty in adjusting to their new roles. There is evidence in the literature that, when special arrangements are made to support young teachers, more rapid and successful adjustments to these roles are made.

RECOMMENDATION 1.4

That schools consider an induction program to develop the self confidence and abilities of beginning teachers in all areas of teaching, including mathematics and science. Further, that schools have available to them information about successful and desirable induction programs.

It was recognised that the quality of support given to beginning teachers by those already in schools, by consultants, and through curriculum documents, can be influenced by teacher educators. Due to a range of historical and political factors there are variations between States in the extent to which primary mathematics and science educators have interacted with education departments and schools during the past few years. It is felt that this interaction should be more intensive.

RECOMMENDATION 1.5

That staff associated with primary teacher education in mathematics and science develop and maintain links with curriculum committees, curriculum developers, and schools with a view to sharing ideas and influencing the directions of developments in primary mathematics and science, and the transition of trainees to full-time teaching positions.

2. ACQUISITION AND TRANSFER OF TEACHING SKILLS AND APPROACHES

See Chapter 3 of the Main Report.

Of central concern to mathematics and science teacher educators was the expectation that particular teaching skills and approaches be acquired by pre-service primary teacher education students, and that these skills and approaches be transferred into teaching practice.

The research of Joyce and others has identified factors related to the acquisition and transfer of teaching skills and models of teaching, and this research has particular implications for the training of teachers in the areas of mathematics and science. This research highlights the effectiveness of certain training components in assisting teachers towards skill acquisition. Careful presentation of theory, modelling and demonstration, intensive practice and structured feedback when used together, are found to be powerful in helping teachers acquire the targeted knowledge, skills and attitudes.

Acquisition of Teaching Skills and Approaches

Data collected in the Project were organised using the components of training listed above and it was found that the theoretical underpinnings for the preferred approaches are carefully presented during lectures and workshops. Teacher educators rely on teaching rounds in schools to provide modelling and demonstration of these approaches and the opportunity for students to practise and obtain feedback on their implementation of the approaches. Most lecturers were sceptical of the availability of these experiences in schools and generally reported that they exercised limited control over the nature and frequency of the teaching practice available in the school situation. In order to provide primary teacher

education students with demonstrations and models of preferred practices in mathematics and science, we recommend:

RECOMMENDATION 2.1

(i) That lecturers teaching in the course continue to employ in their mathematics and science programs those teaching approaches and strategies that they advocate their students should use in schools;

(ii) That resources be made available within institutions to enable the production of video demonstrations of advocated approaches with children, and that a register be compiled to facilitate sharing across institutions;

(iii) That children be involved in campus-based teaching programs in order to alert primary teacher education students to the skills, behaviours and understandings of children of various ages, and to provide them with experience in evaluating different styles of mathematics and science teaching; and

(iv) That peer teaching and micro-teaching processes be used to enable teacher education students to practise, under simulated conditions, the approaches and skills being advocated and that technical feedback be provided on the teaching strategy employed.

Transfer of Learning into Classrooms

Teacher educators were aware of the fact that even when student teachers have developed the highest possible level of knowledge and skill in the preferred approaches, there is no guarantee that these teaching skills and approaches can be applied within classrooms during school experience rounds or in their classrooms when they first commence teaching as graduates. The research cited earlier identified several additional conditions that need to be present for such transfer to occur. First, classroom applications of the ideas being discussed must be forecast throughout the pre-service teacher education program; secondly, student teachers must know how to adapt the teaching approach to the characteristics of a particular classroom and the individual children in that classroom - in Joyce's terms they must develop "executive control"; and lastly, teachers with a high level of skill in those advocated teaching approaches should be involved as coaches to assist with application. The information gathered during the Project highlighted as an area for concern the issue of transfer of institution-preferred approaches to the teaching of mathematics and science. Mathematics and science educators reported limited success in providing the conditions believed to be necessary to support

transfer of learning, and the information provided by beginning teachers confirmed transfer of learning as an issue that needed to be addressed by both pre-service and inservice agencies. The transfer problem would be addressed more adequately if the following recommendations were implemented.

RECOMMENDATION 2.2

That wherever appropriate throughout the course, lecturers:

(i) Orient teacher education students to school and classroom settings

(ii) Refer to ways of adapting the content, teaching skills, and approaches to different classrooms, grades and characteristics of individual children and

(iii) Alert students to the ways in which topics and teaching strategies can be applied across curriculum areas.

RECOMMENDATION 2.3

That lecturers and supervising teachers associated with the course be provided with the opportunity to undertake inservice education on the process of classroom coaching of teacher education students.

RECOMMENDATION 2.4

That mathematics and science staff maintain links with primary schools, for example by: (i) coaching student teachers in classrooms, (ii) teaching children in primary schools, (iii) conducting research and evaluation studies in schools and classrooms, (iv) participating in inservice education for primary teachers, and (v) being involved in curriculum development activities.

RECOMMENDATION 2.5

That close liaison be established between personnel responsible for school experience in the institutions and associated schools to enable greater control to be exercised over the choice of schools, classrooms and supervising teachers in order to ensure that school experience and campus-based experience strongly support one another.

RECOMMENDATION 2.6

That research be conducted by course committees or their agents to identify realistic and practical approaches used by

classroom teachers to cater for individual differences in children in the teaching of primary mathematics and science.

3. RELATING AND INTEGRATING: RELATIONSHIPS BETWEEN PROGRAMS AND WITHIN COURSES

See Chapter 4 of the Main Report.

Relationships of Mathematics and Science With Other Course Components

From the reported relationships of mathematics and science with other components of courses two broad categories of relationships were identified. The first is described in Project Paper 3 as "Structural/Formal" and refers to situations where the relationship is achieved by use of a formal requirement or by the course structure itself. The second category is termed "Unstructured/Informal" and refers to situations where informal devices are used to relate elements of the course.

By far the majority of relationships between mathematics, or science, and other elements of primary teacher education courses were in the second category, occurring informally and through devices which were not built into course structure. A relatively small number of situations were identified where relationships were in the Structured/Formal category. Three types of such relationships existed: (i) formal requirements for mathematics and/or science activities to be conducted by students during school experience rounds; (ii) formal techniques used in a "general method" subject to relate the mathematics or science program with general principles and other curriculum areas; and (iii) specific subjects that explicitly integrate mathematics or science with other curriculum areas. The recommendations which follow from the data collected are:

RECOMMENDATION 3.1

That course committees give attention to the co-ordination of the child development components of their courses with the mathematics and science programs so that the conceptual underpinnings of these programs can be assured and specific amplification and application of child development knowledge to mathematics and science can occur. Further, that staff responsible for child development incorporate into subjects they teach in the course recent applied research about the learning of mathematics and science (for example the New Zealand based Learning in Science Project).

RECOMMENDATION 3.2

That the relationship between school experience and mathematics, or science in the course be strengthened by:

(i) Ensuring that formal requirements for science and mathematics teaching be established and satisfied

(ii) Providing students with the opportunity to observe and participate in soundly based school mathematics and science programs

(iii) Providing maximum possible support during school experience for teacher education students from school and course staff with expertise in mathematics and science.

RECOMMENDATION 3.3

That mathematics and science educators critically examine:

(i) the theoretical bases and teaching methods advocated in other curriculum studies areas of the course

(ii) the appropriateness of integrating mathematics, or science, with other curriculum studies areas of the course.

Inequalities of Opportunity in Mathematics and Science

Inequalities of opportunity linked to gender, class and environment of children have been considered in the Main Report and the following recommendation is made:

RECOMMENDATION 3.4

Given that the acquisition of mathematics and science understandings and skills is the right of all children,

That mathematics and science educators should:

(i) Engage in on-going critical reflection of their own roles in relation to issues of inequality of opportunity as it relates particularly to mathematics and science education

(ii) Support and encourage such critical reflection by primary teacher education students

(iii) Consider the inclusion of specific content in subjects which extends student awareness of issues related to

inequalities linked to gender, class and environment.

4. INFORMATION SHARING BETWEEN PRIMARY MATHEMATICS AND SCIENCE EDUCATORS

See Chapter 5 of the Main Report

An important objective of the Project was to focus on the sharing of information between teacher educators. During the early stages of the Project, it became apparent that information sharing networks of primary mathematics and science teacher educators required support and further development. Lecturers expressed a need to be acquainted with the current situation in pre-service programs in other institutions to determine; what others were doing in their programs, how they were doing it, and the extent of variations between institutions. In particular, the description and review of innovatory course developments and implementation procedures in mathematics and science programs emerged as a major concern.

Data collected indicated that the mechanisms once used by mathematics and science educators in the interchange of ideas and information relevant to their respective teaching areas had recently deteriorated with a resultant breakdown in both group and individual information networks. Given appropriate resources in 1985 or subsequently, it is recommended:

RECOMMENDATION 4.1

That those responsible for course or subject review and development in individual institutions be given additional assistance from the Project Team in the consideration and possible implementation of practices and procedures that arise from recommendations of the Project.

RECOMMENDATION 4.2

That the Directories in mathematics and science developed as part of the Project be used to establish a data base of innovation in primary mathematics and science teacher education. Further that consideration be given to maintaining and expanding this data base.

RECOMMENDATION 4.3

That the collection of curriculum materials assembled at the November conference be made available to course committees in institutions around Australia on short-term loan and that the Project Team assume responsibility for co-ordinating the loans.

RECOMMENDATION 4.4

That consideration be given to the re-establishment of lecturers' associations in primary mathematics and science education in Victoria.

5. STRUCTURE OF PROGRAMS

See Chapter 6 of the Main Report.

Information was gathered on the structure of mathematics and science components of Victorian primary pre-service teacher education courses. The emphases, sequencing, time allocation and curriculum design of compulsory mathematics and science programs was noted, and the optional mathematics and science elements were examined to determine their emphases, availability, and attractiveness to students.

These data are presented in Project Paper 5 in such a way as to enable comparison between the 14 campuses. Where appropriate, campuses were clustered according to particular structural criteria and structural patterns were identified. Given time and resource constraints, no attempt was made to identify the strengths and weaknesses of particular approaches to structuring the mathematics and science components in primary teacher education courses.

The recommendations that follow from the descriptive information gathered are:

RECOMMENDATION 5.1

That the variety of structures of mathematics and science programs identified through the project be considered during internal reviews of courses undertaken at individual institutions.

RECOMMENDATION 5.2

That campuses which offer a major study in mathematics and/or science identify and reduce those factors which may prevent interested students from undertaking these major studies in the course.

6. MATHEMATICAL AND SCIENTIFIC APTITUDES AND ATTITUDES

See Chapter 7 of the Main Report.

Transition From School

The data showed that the majority of primary teacher education students had studied mathematics at secondary school; 87 percent had studied mathematics to at least Year 11, and 69 per cent had studied a science to Year 12. Level of mathematics and science studied at school was strongly linked to the students' attitudes to these subjects. Despite a widespread assumption that primary teacher education students generally have a negative approach to mathematics and science on entry to their courses, the data suggest that strongly negative attitudes are confined to about a fifth of the students.

Among teacher educators, there was widespread scepticism about the value of higher level school mathematics and science subjects as preparation for primary teacher education courses. A major concern was that the emphases in higher level subjects at school, particularly in mathematics, were not the emphases needed as a pre-requisite background for teaching at primary school level. What appears to be needed are school mathematics and science subjects which emphasise understanding of fundamental concepts such as problem solving.

In the absence of such approaches at secondary school, a sizeable proportion of the time in primary teacher education courses is devoted to increasing student teacher understanding of mathematics and science. Attainment at school in these subjects is seen by some staff as an indication of the potential of student teachers to cope with the new approaches.

RECOMMENDATION 6.1

That course committees review their entrance requirement policies in the light of changes to courses at upper secondary school levels. It would be advantageous if prospective primary teachers could study appropriate mathematics and science subjects to at least the equivalent of year 11 level of the secondary school before entering primary teacher education courses.

Testing and Remediation

Despite the assertion that primary teacher education mathematics requires students to adopt an approach different to that used in secondary school, many mathematics departments assess the mathematical competence of students on entry to primary teacher education. Most of these tests are concerned with computational skills. The major reasons given for testing programs are: to identify students in need of remediation, to select students for alternative teaching approaches, or to gather information on which to plan courses.

There is some debate about the advantages of testing, particularly early in teacher education courses. Those who advocate the abolition of tests do so on the grounds that their use perpetuates an approach prevalent at the secondary school level, which has had the effect of turning students away from mathematics. There is also concern for the narrow range of outcomes which can be assessed using tests of computational skills.

Few science departments test their students on entry to primary teacher education. This is probably associated with the fact that departments make few assumptions about what has been learned by students before entry. However, for course planning purposes, it would seem useful for a test of scientific understanding to be available for consideration by science departments.

RECOMMENDATION 6.2

That the rationale for existing cognitive testing programs in mathematics and science be reviewed. It is recommended that:

(i) Mathematics educators review the nature of tests currently given at the beginning of teacher education courses, to ensure that they are valid.

(ii) a system level agency, such as the CTEC or VPSEC or the science lecturers association sponsor a review of instruments which profess to measure scientific understanding with a view to developing an instrument for use in primary teacher education courses.

Attitudes and Aptitudes

Most mathematics and science educators recognise the importance of cultivating positive attitudes of students towards mathematics and science, and courses are planned with a view to overcoming negative attitudes among students. As indicated earlier, there is evidence that strongly negative attitudes towards mathematics and science on entry to primary teacher education are confined about 20 per cent of students. This is contrary to the belief held by many teacher educators. The data also show that primary teacher education programs orient students very positively towards teaching mathematics and science.

Given the importance of identifying students with negative attitudes, and the need to monitor the effect of tertiary programs on attitude, the following recommendation has been formulated:

RECOMMENDATION 6.3

That if attitude scales are used in courses, they should satisfy the following criteria:

(i) The attitude being measured is clearly defined;

(ii) Any subscales are identified;

(iii) The scales possess appropriate internal consistency and sensitivity.

From this brief description, it can be deduced that there are variations in the emphasis on the determination of cognitive and affective characteristics of students. Whatever the nature and extent of this emphasis, it seems to be important that the purposes of data collection in these areas be fully explained to students.

Evaluation of Mathematics and Science Programs

In general the idea of evaluation of social programs has become well established over the past two decades. Two major approaches have become evident; evaluation as a method of accountability, and evaluation as the basis for improvement of existing arrangements. The latter of these alternatives seems to be the more appropriate reason for evaluation of mathematics and science programs in primary teacher education courses although there are also advantages in having a body of information assembled for accreditation purposes. However, it is evident from this study that self evaluation programs are not widespread. This leads to the following recommendation:

RECOMMENDATION 6.4

That mathematics and science educators be encouraged to monitor the effects of their programs in the course and that a variety of techniques be considered, for example using 'before' and 'after' designs, or action research approaches based on carefully monitored personal practice.

APPENDIX 6

SCOPE

Participation rates in maths and science, Years 11 and 12, 1986

The figures below are based on an initial return rate of about 80% of Victorian schools from the 1986 SCOPE survey. They indicate the participation rates for 1986 students in years 11 and 12, in the mathematics and science subject areas.

	Mathematics			Science		
	Males	Females	TOTAL	Males	Females	TOTAL
Year 11	94.9	88.4	91.4	68.0	62.6	65.1
Year 12	70.5	51.0	59.2	58.4	57.6	57.9
Years 11 & 12 Combined *	95.1	90.7	92.5	83.1	77.6	79.9

If completion of the VCE requires that all students particpate in both mathematics and science/technology over the two year period covering years 11 and 12, and if class sizes remain constant, then the number of maths classes in years 11 and 12 combined would be expected to increase by about 8% (7.5 ÷ 92.5) and the number of science/technology classes would be expected to increase by about 25% (21.1 ÷ 79.9), under current enrolment figures.

* "Science" includes computer science, computer studies, and technological studies (particularly practical subjects in technical schools).

John Taylor
SCOPE COORDINATOR

5 February 1987